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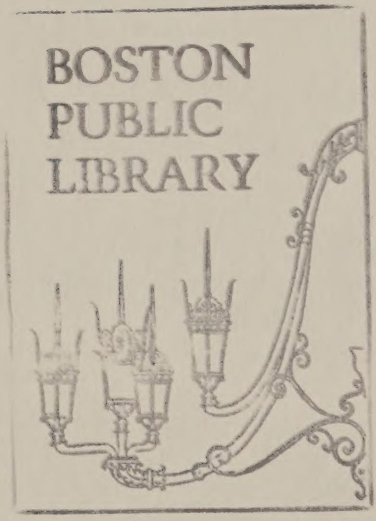

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City of Boston
Town of Brookline

Phase 1 Muddy River Flood Control, Water Quality and Habitat Enhancement, and Historic Preservation Project

Volume 1 – Report
EOEA #11865
Draft Environmental Impact Report

December 2001

Prepared By: **CDM**

In Association with:

Jason M. Cortell and Associates Inc.
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January 21, 2002

Mr. Robert Durand
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251 Causeway Street, Suite 900
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Subject: Draft Environmental Impact Report; EOEA#11865
Phase I Muddy River Flood Control, Water Quality and
Habitat Enhancement, and Historic Preservation Project

Dear Secretary Durand:

On behalf of the City of Boston and the Town of Brookline, we are forwarding to you three copies of the Draft Environmental Impact Report in compliance with MEPA Regulations (301 CMR 11.00-Section 11.06) and the ENF Certificate you issued on April 24, 1999.

Please note that over the past six months, the Citizens' Advisory Committee you established has provided both comment on and input to the content of the DEIR, most of which have been incorporated into the draft. Furthermore, as required by MEPA Regulations (301 CMR 11.00-Section 11.09) and your Certificate establishing a Special Review Procedure (April 24, 1999), this DEIR has been submitted to the CAC for their final review, 30 days in advance of this formal submittal to MEPA.

In addition, comments received on the ENF and your Certificate have been summarized and responded to. These can be found in Appendix K.

Finally, the Proponents are requesting that the comment period be extended to 60 days allowing, to the greatest possible extent, the public to comment on the DEIR.

Copies of the DEIR (either in hard copy or CD form) are available from John Burckardt, BPRD's project manager, via e-mail at jburckardt@ci.boston.ma.us, by telephone at 617-635-4505, or in writing at, BPRD, 1010 Massachusetts Avenue, Boston, MA 02118.

Very truly yours,

Bruce R. Conklin

Bruce R. Conklin, P.E.
Vice President
Camp Dresser & McKee Inc.

Attachment: DEIR Circulation List (301 CMR 11.16)

c: Margaret Dyson, BPRD
Thomas Brady, Town of Brookline

Phase 1 Muddy River Project Flood Control, Water Quality and Habitat Enhancement, and Historic Preservation Project

EOEA File No. 11865

Draft Environmental Impact Report

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Date of Filing: January 31, 2002

Muddy River Rehabilitation Project
Emerald Necklace
Boston and Brookline, Massachusetts

Vision Statement

The Emerald Necklace is an internationally renowned 19th-century linear park system and a nationally significant work of landscape architecture, sanitary engineering, and city planning. Frederick Law Olmsted Sr., the leading landscape architect of that era, created these public spaces to solve a difficult series of public health and civil engineering problems and provide verdant scenery to "bring peace and refreshment to the city dweller". The spine of the Emerald Necklace, the Muddy River, a 3.5-mile linear system, integrates glades, dells, sweeping vistas, reflecting pools, the Babbling Brook, bike paths, walkways, tree-lined parkways, shorelines and "beaches". This unified system of linked parks is one of the most uniquely designed historic urban waterways in the nation. The challenge today is to achieve a balance between historic landscape preservation principles, resource protection regulations, public safety measures and modern engineering practices.

Fredrick Law Olmsted, Sr.
Landscape Architect
Emerald Necklace, Boston

As a result of changes in land use patterns associated with urbanization, both the engineering and the artistry of Olmsted's creation are in need of renovation. The most serious issue is the presently diminished flood handling capacity of the park system as evidenced by the damage caused by two recent storms that brought civic leaders, politicians, and community groups together to reexamine the condition of this natural treasure and its importance to the metropolitan area. With increasing regularity, moderate rains necessitate emergency response measures to address storm water overflow in Fenway colleges and universities, Longwood medical institutions, numerous Brookline businesses and residences and the public transit facilities. The commitment of political will associated with health, safety and ecological improvements to Olmsted's municipal masterwork has inspired a multi-jurisdictional park and public works project to restore the Muddy River's civil engineering structure, flood-carrying capacity, historic integrity, bucolic scenery and ecological vitality.

The Muddy River Rehabilitation project is one of the most ambitious and comprehensive landscape preservation projects in the nation. The vision

set forth for recovering Olmsted's original concept of a unified system of linked parks is designed to protect the health, safety and welfare of the citizens, re-establish the Olmsted scenery to approach its former glory, and reinvigorate the overall park experience for the benefit of everyone in the community.

The project, which includes improvements to infrastructure, dredging sediment, removing invasive species, rehabilitating and restoring wetland habitats and historic resources addresses the predominant stresses that currently undermine the park system. Invasive exotic vegetation has overtaken large areas of the river and its banks. Over five acres of mature *Phragmites* (a tall invasive reed grass) choke the river and diminish the flood-carrying capacity of the waterway. The reeds have displaced other plant species and undermine biodiversity. Contaminants in the river sediment continue to degrade water quality, limiting the number of vertebrate and invertebrate species that could contribute to a balanced ecology The Muddy River Rehabilitation will correct major issues of physical deterioration, public safety hazards and address critical public needs.

The collaboration process that created the rehabilitation project remains as important as the project itself. Over the past years, the municipalities have been implementing park improvements using the framework of the Massachusetts Department of Environmental Management's 1990 *Emerald Necklace Master Plan*. The project vision exemplifies a renewed appreciation of the Emerald Necklace and reinforced political will to commit resources to rehabilitate a world-class park system. Coordinated maintenance and management can successfully reclaim many areas. The municipalities are committed to exploring new and innovative ways to maintain the parks in perpetuity, and protect and preserve the public sector's investment. Boston and Brookline will aggressively pursue partnerships with private sector and cultural institutions, and examine fiscal and organizational models that could enhance park maintenance and management practices. A Memorandum of Understanding (MOU) signed in 1999 by local and state agencies institutionalizes the commitment of collaboration and cooperation amongst the respective authorities in project planning, permitting, funding, and implementation.

One hundred years ago, Olmsted believed that nature could restore the human mind and spirit and conceived the unique urban landscape called the Emerald Necklace to bring a natural regenerative experience to city dwellers. Like their 19th century predecessors, today's civic leaders, politicians, and citizens must commit to stewardship for future generations, and sustain a legacy worthy of Olmsted and his peers. Across the country, Olmsted has left millions of urban residents some of this country's greatest treasures. Our citizens and their elected officials have come together in an exceptional effort to protect those treasures for the next generations.

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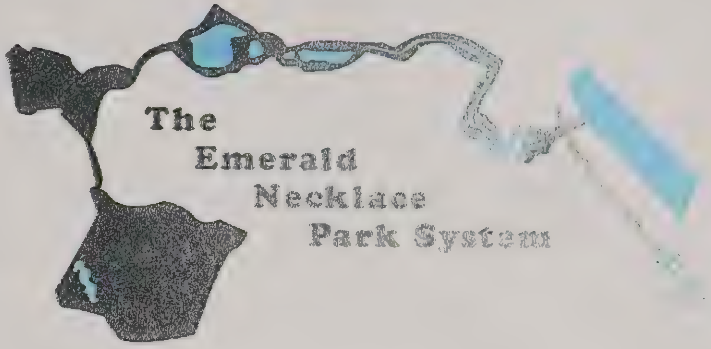
Executive Summary

Executive Summary

Rehabilitating the Emerald Necklace

What is the Emerald Necklace?

The Emerald Necklace is the oldest park system in the United States and the largest in Boston —a swath of hills, meadows, other open spaces, and waterways as unique and diverse as the 300,000 people who live in its watershed. Stretching more than [illegible] miles from Dorchester to Back Bay, the Emerald Necklace is composed of six parks and related waterways:



- Franklin Park (Scarboro Pond)
- Arnold Arboretum
- Jamaica Park (Jamaica Pond)
- Olmsted Park (Ward's, Willow, and Leverett Ponds)
- The Riverway
- The Back Bay Fens, which joins the Riverway via the Muddy River

The Emerald Necklace is the only remaining intact linear park designed by renowned landscape architect, Frederick Law Olmsted.

The Emerald Necklace is valued not only in Boston, but also on a national level because of its great history. Nearly a century ago, the City of Boston and Town of Brookline hired America's first landscape architect, Frederick Law Olmsted, to create special green "retreats" for city-dwellers. Answering the challenge, Olmsted planned, designed, engineered, and constructed the parks, waterways, and vehicular and pedestrian parkways known as the Emerald Necklace. Among his many impressive accomplishments—including design/construction of New York's Central Park, Chicago's Washington and Jackson Parks, and Detroit's Belle Isle Park—Olmsted's Emerald Necklace is considered the most complex:

- It's functional, improving sanitary conditions and flood control.
- It's multifaceted, serving as an educational and recreational resource.
- It's cohesive, uniting diverse, urban neighborhoods by green space.

In the middle of a busy city, millions find respite in the Emerald Necklace.

Olmsted's social vision—that the parks bring "peace and refreshment" and serve as "meeting grounds for people of different classes and backgrounds" – is still true today. It's no wonder the Emerald Necklace is listed on the National Register of Historic Places. And it's no wonder that many of Boston's world-renowned cultural, medical, and educational landmarks – such as the Museum of Fine Arts, Children's Hospital, and the Berklee College of Music – were built adjacent to the Emerald Necklace. What is a wonder is the Emerald Necklace: it's as important in defining Boston's and Brookline's identities as the diverse neighborhoods, monuments, museums, nationally-recognized medical facilities, and world-class learning institutions that lie adjacent to its boundaries.

What is the Emerald Necklace?

- A National Treasure – 1,000 acres of green space listed on the National Register of Historic Places
- A State Resource – a Boston landmark and "front door" to dozens of our cultural, medical, and educational institutions
- An Urban Jewel – green "retreats" where people escape city life conveniently, without leaving the city
- An Environmental Legacy – diverse in vegetation, wildlife, and opportunity for passive and active recreation.

This Muddy River Project is the First Step toward Rehabilitation

Created more than a century ago by a visionary who believed that nature could restore the human mind and spirit, the parks and waterways within the Emerald Necklace need rehabilitation.

This need was first addressed in 1989, and then updated in 2001, by the comprehensive Emerald Necklace Parks Master Plan (the Master Plan). More than 52 improvements aimed at rehabilitating and preserving the Emerald Necklace are grouped under the Master Plan, which is organized in four phases:

> ***"This effort (to rehabilitate the Muddy River) will be a national model ... the beginning of a great public sector project that will encourage private sector efforts."***
>
> ***- Robert Durand, State Secretary of Environmental Affairs, February 24, 1999***

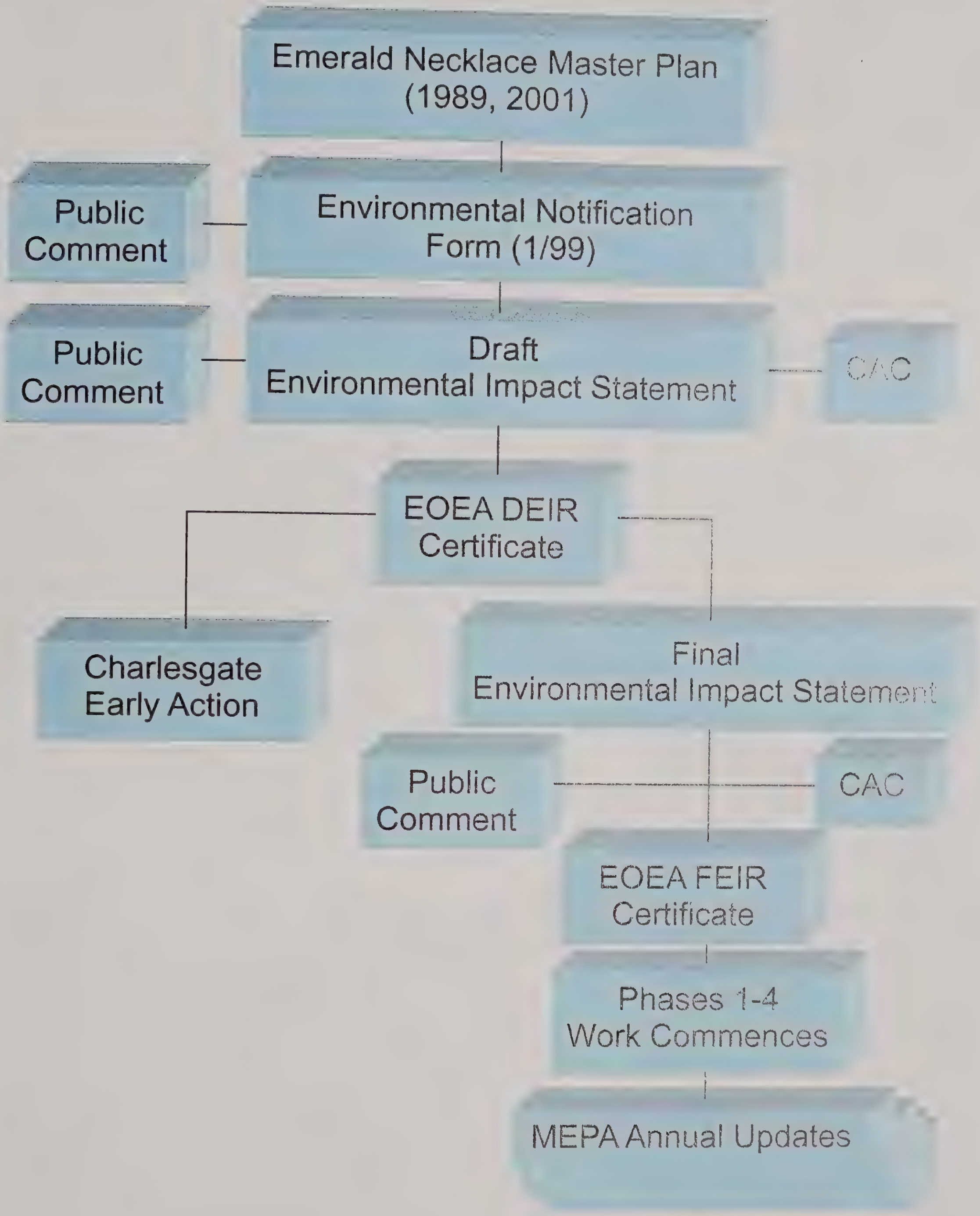
- Phase I: Dredging, flood control, water quality improvements, aquatic/riparian habitat enhancement, historic restoration, and best management practices within the Muddy River area (the Back Bay Fens, Riverway, and Olmsted Park and its waterways).

- Phase II: Historic landscape improvements, revegetation, major traffic and pedestrian circulation improvements, major building and vehicular bridge restoration (also within the Muddy River area).

- Phase III: Minor traffic circulation improvements, small building and pedestrian bridge restoration (also within the Muddy River area).

- Phase IV: Park and water body improvements in the remaining areas of the Emerald Necklace (i.e., Jamaica Park, Arnold Arboretum, and Franklin Park/ Scarboro Pond).

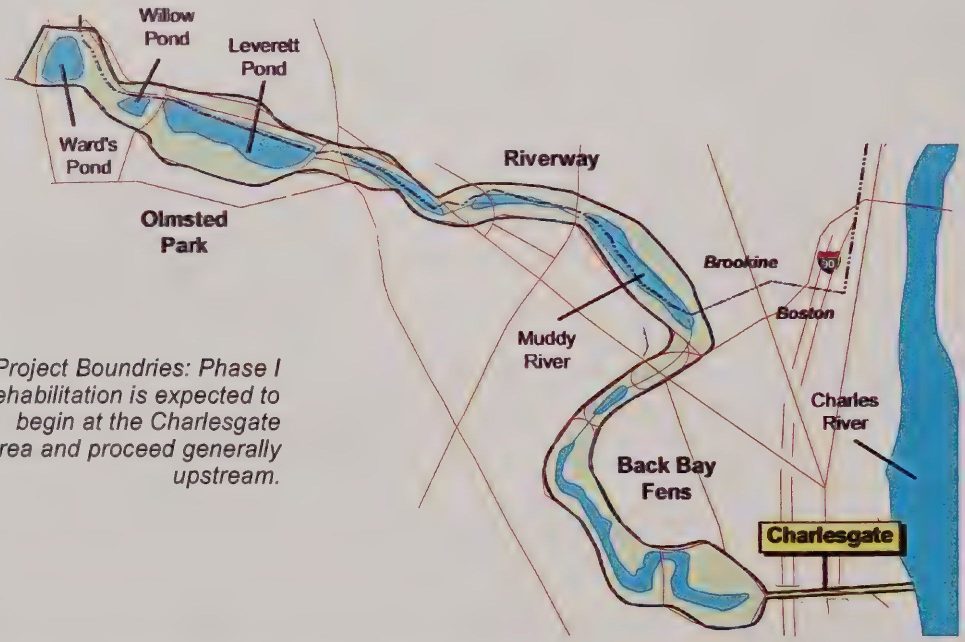
Emerald Necklace Master Plan MEPA Process


Emerald Necklace Master Plan (1989, 2001)
Public Comment
Environmental Notification Form (1/99)
Public Comment
Draft Environmental Impact Statement
CAC
EOEA DEIR Certificate
Charlesgate Early Action
Final Environmental Impact Statement
Public Comment
CAC
EOEA FEIR Certificate
Phases 1-4 Work Commences
MEPA Annual Updates

Due to the project's scope and size, the Massachusetts Environmental Policy Act (MEPA) governs environmental review. Pursuant to MEPA, an Environmental Notification Form (ENF) was submitted to the Secretary of Environmental Affairs in April 1999. The Secretary then issued two certificates, one for the Environmental Impact Report's (EIR) scope and requirements, the other establishing an area-wide special review process, which includes these elements:

- A Draft EIR (DEIR) and Final EIR (FEIR).
- An opportunity for activities in the Charlesgate and Leverett Pond (sand bar) areas (see below) to proceed following MEPA review and DEIR certification.
- Annual filing and public review of project updates after the FEIR is completed.
- Designation of a Citizen's Advisory Committee (CAC) — Which will assist in evaluating the project's efforts to reach its goals, while minimizing impacts to the environment.

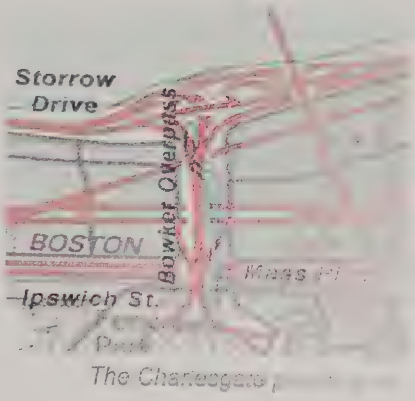
This DEIR focuses on the Master Plan's Phase 1 and further divides Phase I into three areas — Charlesgate, Leverett Pond (sand bar), and Muddy River. The entire project area begins with the Muddy River confluence with the Charles River and extends 3.5 miles upstream through the Back Bay Fens, the Riverway, Olmsted Park, and into Ward's Pond. Charlesgate covers the area between Boylston Street and the Charles River, and Leverett Pond is part of Olmsted Park (see Figure ES-1). In general, work would likely proceed geographically from the Muddy River confluence to Ward's Pond upon FEIR approval; however, work in the Charlesgate area may begin subsequent to review and certification of this DEIR.



Project Boundries: Phase I rehabilitation is expected to begin at the Charlesgate area and proceed generally upstream.

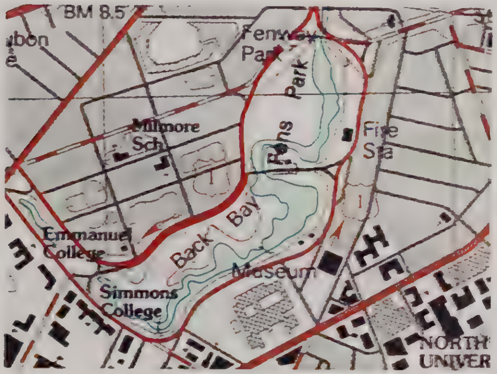
The above shows the study area; a brief description of each Phase I project area follows. Detailed information is provided in Section 4.0 of this DEIR.

Charlesgate



The Charlesgate [illegible]

The Charlesgate area, the last portion of the Muddy River before it empties into the Charles River, is a Metropolitan District Commission (MDC) property located entirely within Boston. The project area includes parkland extending from the Richardson Bridge (Boylston Street) to the Charles River. Several major roadways are within the project area as well; the elevated Bowker Interchange, Commonwealth Avenue, Beacon Street, Bolyston Street, local streets with connections to Storrow Drive, the Massachusetts Turnpike, Ipswich Street, and the CSX railroad. Land use [illegible] residential; the Massachusetts Bay Transportation Authority (MBTA) [illegible] transit via bus, subway, and rail service through the area.



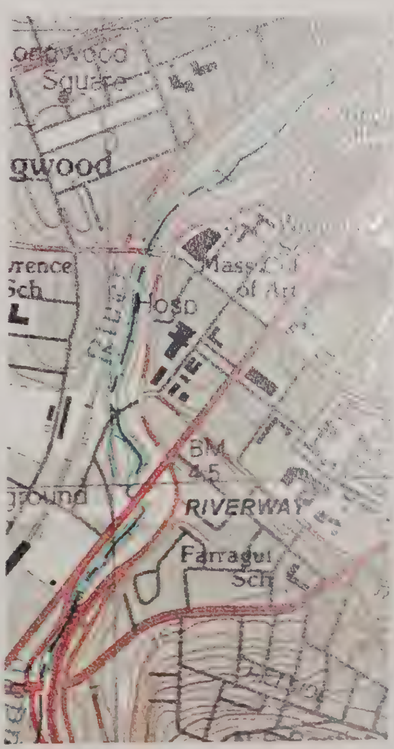
The Back Bay Fens project area.

Back Bay Fens

The Back Bay Fens area includes parkland [illegible] southerly (upstream) along the Muddy [illegible] Bolyston Street at the Richardson Bridge to th[illegible] Landmark Center (formerly the Sears Build[illegible] intersecting roadways, and the parallel road[illegible] Park Drive and The Fenway. The area is scatter[illegible] historical monuments(e.g. TheWar Memorial, [illegible] Rose Garden), cultural institutions (e.g., [illegible] Fine Arts, Gardner Museum), and an impressive number of colleges and universities (e.g., Simmons, Emmanuel, and Northeastern). Fenway Park and Kenmore Square are also nearby.

The Riverway

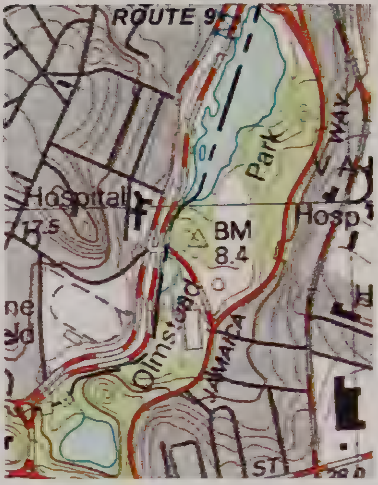
The Riverway begins at the twin six-foot culverts under the Riverway Parkway at the Sears Rotary. The MDC-maintained Riverway parkway runs parallel to the Muddy River's east side with the MBTA Green Line tracks running along the west side. Three islands, all deisgned by Olmsted, are part of The Riverway area. One island, located between Brookline Avenue and Netherlands Road, is maintained as a park and accessible to pedestrians by stairs and bridges; the other two islands are neither maintained nor accessible. Wheelock College and the Longwood Medical area are located adjacent to The Riverway's boundaries.



The Riverway project area.

Olmsted Park and its Waterways

Olmsted Park includes three ponds: Leverett, Willow, and Ward's. Leverett Pond has three islands along its western edge and also contains a large sand bar from the largest stormwater outfall into the Muddy River —the Village Brook Drain. Major roadways around the ponds include Route 9, The Jamaicaway, Willow Pond Road, and Pond Avenue. Beyond the park's boundaries are several residential neighborhoods and the Brook House. The U.S. Veterans Administration Hospital, and the Museum of Native Americans are nearby.



The Olmsted Park project area.

Problems in the Emerald Necklace

Preserving the Beauty

Created nearly 100 years ago, the Emerald Necklace in general, and the area surrounding the Muddy River in particular, have experienced extensive urbanization. As the populations of Boston and Brookline grew, they brought with them the attendant expansion of buildings, roadways, traffic, and congestion—all of which have adversely affected the watershed.

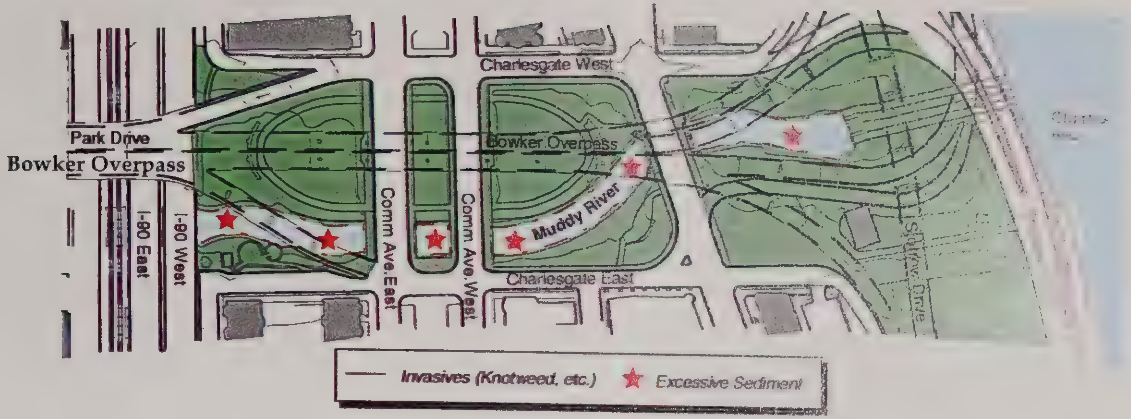
- Flooding has worsened because there is little natural storage left in the widely paved watershed, and sediment and debris have washed into the river constricting flood-carrying capacity.
- Water quality has deteriorated as an array of natural and man-made compounds are carried off the land surface during rainstorms and deposited into the river and accumulated in the sediment.
- Non-native invasive species of flora such as *Phragmites,* knotweed, and buckthorn have overtaken portions of the river, pushing out native species, creating safety hazards, eliminating natural habitats, and greatly limiting the diversity of wildlife that can live within the watershed.

As a result, Olmsted's distinctive landscape has declined in richness and diversity.

Following is a brief description of each study areas' physical features, biological environment, and historic significance. Extensive detail is provided in Section 4 of this DEIR, "Existing Conditions."

Charlesgate

Physical Features — The Muddy River channel in this area, generally about 40 to 50 feet wide and narrowing under seven bridges within its reach, consists entirely of stone and concrete construction with no wetland vegetation. The surrounding landscape is either grass or bare ground with some trees and shrubs, and scattered stands



Knotweed and excessive sediment are causing problems in the Charlesgate [illegible]

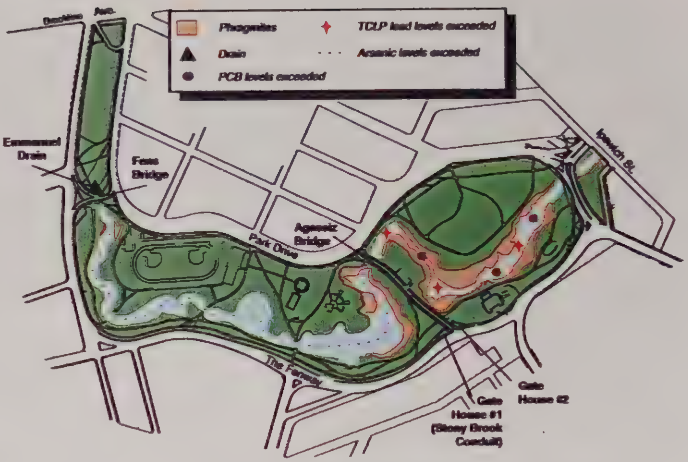
of Japanese knotweed. The normal water surface elevation during dry weather approximates the Charles River's (about 8 feet); average flow during dry weather is between 2 to 5 cubic feet per second (cfs). The Massachusetts Department of Environmental Protection (MA DEP) has classified the entire Muddy River watershed as "Class B" — waters that are swimmable and fishable. However, historical data [illegible] that Charlesgate experienced excessive nutrient conditions during 1974, [illegible] 1992. Charlesgate's sediment contains varying, but not excessive, concentrations of petroleum hydrocarbons, polynuclear aromatic hydrocarbons (PAHs), and [illegible] metals. However, the larger problem is the abundance of sediment in this [illegible] much sediment has reduced the river's flow capacity.

Biological Environment — Fanwort, duckweed, and filamentous algae (aquatic vegetation) are found throughout Charlesgate. Species-specific information on [illegible] was not available for this area, but due to its proximity to the Back Bay Fens, it [illegible] probable that fish such as the Large Mouthed Bass, Pickerel, and Yellow Perch [illegible] here as well. Several species of birds (e.g., the American Crow and Robin, Blue Jay and Black-Capped Chickadee) and reptiles (e.g., the Common Musk Turtle and Red-Eared Slider) also inhabit the area.

Historic Significance — Olmsted designed the Charlesgate area, which he called the Beacon Street Entrance, between 1878-1895. His vegetative plan was extensive, but the majority of the plantings did not survive. Olmsted's Richardson iron railroad bridge, constructed in 1880, was razed in 1962 as part of a land taking by the Massachusetts Turnpike Authority (MTA); however, in the 1980s, the arches and historic balustrades were restored. The Bowker Overpass, which connects Storrow Drive to Park Drive was not part of Olmsted's original area plan: the MDC constructed the overpass in the mid-1960s. The Commonwealth Avenue Mall, part of Charlesgate, was designated a landmark by the City of Boston in 1978. The entire Charlesgate area is included on the National Register of Historic Places as part of the Back Bay District.

The Emerald Necklace parks still serve "meeting grounds," just as Olmsted intended.

Back Bay Fens



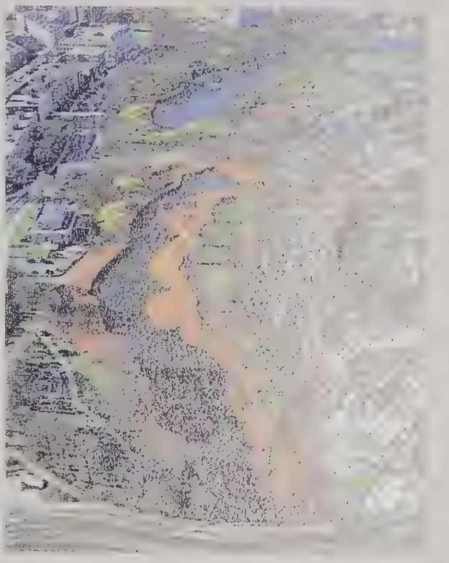
Problems in the Back Bay Fens include excessive concentrations of arsenic, lead and PCBs in addition to dense Phragmites

Physical Features — Like the Charlesgate area, the Back Bay Fens is located entirely within the City of Boston. The Fens is bordered on both sides by grassed parkland accessible by paved and unpaved paths, making it a popular recreational area. Extremely dense and large stands of the giant reedgrass (*Phragmites australis*) grow along much of the Muddy River's bank in the Fens, severely constricting flood-flow capacity. Numerous small stormwater outfalls are sprinkled throughout the Fens; large outfalls include overflow from the Stony Brook Conduit at Boston Gate House No. 1 and the Emmanuel Drain. Channel widths in the Fens range from 50 to 200 feet. Like Charlesgate, normal water surface during dry-weather is approximately 8 feet, and the average flow during dry-weather is between 2 to 5 cfs. Unlike Charlesgate, the Fens experienced severe flooding during the October 1996 storm, when peak flow in the upstream end reached about 520 cfs, and downstream about 1,030 cfs. Although deemed swimmable and fishable by MA DEP, water quality tests conducted in December 2000 showed excessive levels of fecal coliform bacteria. Sediment borings taken summer 2000 contained elevated levels of lead (between Agassiz Road and Ipswich Street), arsenic (between the Emmanuel Drain and Gate House No. 1), and polychlorinated biphenyls (PCBs) (between Gate House No. 1 and Ipswich Street).

Flooding has been a major problem in recent years in the Muddy River.

Biological Environment — A maintained parkland, the Fens is beautified by approximately 1,500 trees (flowering, canopy, heritage, and evergreen) and more than 26,000 square feet of shrubs. Unfortunately, some of that beauty is masked by invasive plant colonies, such as *Phragmites*, that occupy more than 380,000 square feet, screening park vistas from bridges and constricting the Muddy River's flow and storage capacity. PCBs have damaged the fish population, which includes the Large Mouthed Bass, Yellow Perch, American Eel, Goldfish, and Common Carp. In 1990, the Massachusetts Division of Fisheries and Wildlife issued a Public Health Advisory after finding PCBs in edible fish tissue. More than a dozen different species of birds (e.g., the Red-Winged Blackbird, Mallard, and European Starling) and two types of reptiles (i.e., Common Musk Turtle and Red-Eared Slider) inhabit the Fens, as do several wetland plants (e.g., Red Maple, Cattails, Glossy Arrowwood).

Thousands of flowering trees and shrubs adorn the Back Bay Fens.



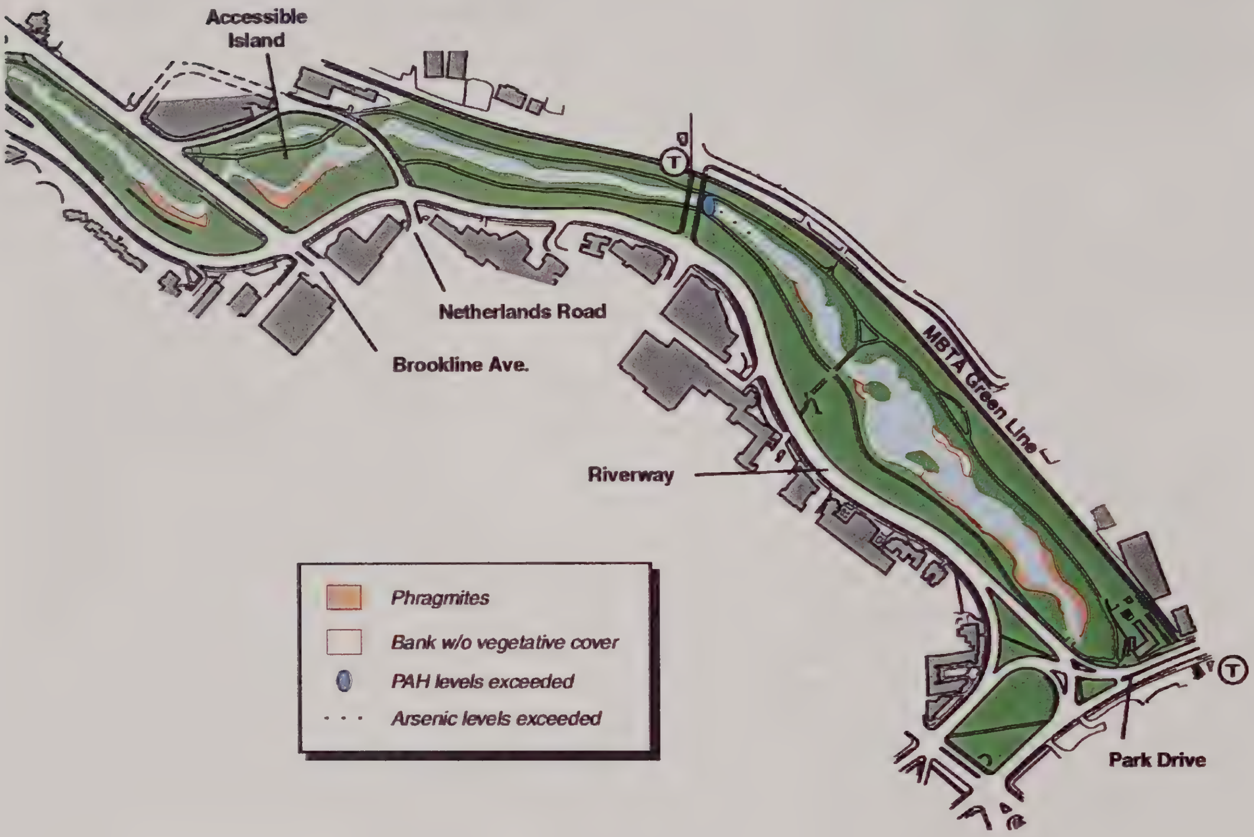
Phragmites, the beige areas along [illegible] are literally choking the [illegible] constricting flow and flood [illegible]

Historic Significance – Olmsted designed and constructed the Fens between 1878-1895. His intent for the Fens was to create the feeling of a restored natural tidal marsh with a system of drives, walks, and boating launches, while at the same time solving some sanitary engineering problems. By designing extensive low islands planted with sedge, Olmsted wanted to "prevent development of surf that would undercut the banks during high winds and heavy rains ... the narrow, curving waterway, in addition to providing landscape interest, provided no place where storm winds could build up heavy surf" (from Olmsted's 1886 "Paper on the Back Bay Problem and Its Solution"). The Fens was redesigned by Arthur Shurtleff between 1910-1933, when recreational facilities, ornamental gardening (the James Michael Curley Rose Garden), and non-recreational facilities (the Fire Control Center) were built. Active sports replaced the quieter uses Olmsted had intended. More changes were on the horizon: war memorials were added in 1940 and in the 1940s and 1950s parkland was taken for road-widening, and portions of the river were replaced with culverts and filled to configure new [illegible] 1971, the Fens was added to the National Register of Historic Places; in 1983, the City of Boston designated it a landmark.

The Riverway

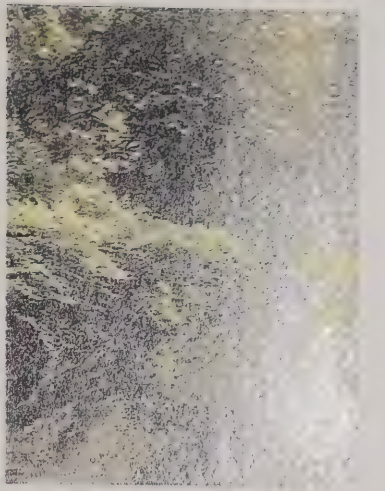
Physical Features – With the Muddy River transversing the line between Boston and Brookline, The Riverway is a parkway and grassed parkland with numerous paralleling and intersecting streets. All but two sections of The Riverway are naturalized terrain designed by Olmsted. In the area of the former Sears parking lot, the river remains in twin 6 foot diameter pipes below ground. Several bank areas are without vegetative cover and must be stabilized to avoid further erosion by stormwater runoff and river flow. River widths in this area range from 30 to 150 feet. Like the Back Bay Fens and Charlesgate, flows during dry-weather are around 2 to 3 cfs and the elevation is about 8 feet. Significant flooding occurred in the Riverway during the October 1996 storm, with peak elevation reaching almost 19 cfs. Because of the high river waters, floodwaters from local drainage systems tributary to the Muddy River could not discharge; as a result, local neighborhoods were flooded and the Kenmore MBTA station was inundated with 30 million gallons of water. Water quality has also been a problem: past testing has indicated that the bacteriological water quality standard was not met in 1974, 1986, 1992, and 1998, and that the

Riverway experienced excessive nutrient conditions in 1992, 1995, and 1998. In October and December 2000, fecal coliform bacteria failed to meet water quality standards, especially during wet-weather conditions, at several sampling locations. And while no detectable levels of PCBs were found in its sediment, arsenic and PAHs concentrations were above the MA DEP landfill reuse levels.



Biological Environment – The area surrounding The Riverway is an urban park with mature trees, grass, and some shrub. With more than 900 trees, 270,000 square feet of woodland, and 20,000 square feet of shrubs, the area should be a verdant paradise; however, the parkland has been invaded by about 270,000 square feet of *Phragmites* and knotweed. In the river, dense growth of *Phragmites* has blocked the flow channel at the Island Area (between Brookline Avenue and Netherlands Road) and has severely narrowed the flow channel at other locations, particularly upstream of the two six-foot culverts at Park Drive and The Riverway intersection. Erosion is also a problem: bare lawns, wash outs of storm sewers, and overuse compaction have contributed greatly to the land's demise. Several fish species, such as the Red Fin Pickerel, Brown/Yellow Bullhead, and Pumpkinseed swim the Riverway's waters; but PCBs were found in their edible tissue in 1990, and the Public Health Advisory issued then is still in effect. More than a dozen species of birds, including the Black and White Warbler, Downy Woodpecker, and Mourning Dove, inhabit the parkland, along with five species of wetland plants (e.g., the Speckled Adler and Purple Loosestrife) that are being choked by the giant reed grass (*Phragmites australis*) and knotweed.

Historic Significance — Olmsted designed and constructed The Riverway from 1880-1895. Here, Olmsted's intent was to create a landscape with the character of a New England fresh-water stream. In 1904, John Charles Olmsted, described the accomplishment as "a beautiful and popular water park [that] represents the transformation of what was once an ugly, neglected, unsanitary stream." Due to its narrowness and terrain, The Riverway was not suited to active recreation fields and organized sports and, therefore, escaped the massive redesigns that occurred in the Fens. However, the roadways in this area were not as fortunate. Major changes—such as the Route 9 overpass, rotaries, road widening, right-hand lane turns, exit and entry ramps, and parking lots—were constructed between 1936 and 1959. The Riverway was placed on the National Register of Historic Places in 1971, and designated a City of Boston landmark in [illegible]


The Riverway

Olmsted Park and its Waterways

Olmsted Park includes three ponds: Leverett, Willow, and Ward's Ponds. The physical features around the each pond are somewhat varied (e.g. grassed parklandand woodlands along the perimeters, surrounded by roadways such as Route 9 and the Jamaicaway). The biological environments are more similar in that they contain the same types of fish, wildlife, and wetlands. Only distinctions are noted below (for more detail, see Section 4 of this DEIR).

Physical Features

- *Leverett Pond* includes three islands on its western side and has a large sand bar from the largest stormwater outfall into the Muddy River—the Village Brook Drain. Another drain, the Daisy Field Drain, also contributes stormwater flows. Peak elevation during the October 1996 storm was about 19 feet, 11 feet higher than normal. Water quality standards were not met in 1986, 1992, 1995, and 1998, and excessive nutrient conditions occurred in 1992, 1995, and 1998. While fecal coliform bacteria concentrations were very low/not detected in the Village Brook Drain in October and December 2000, testing showed high levels during wet- and dry-weather conditions in the Daisy Field Drain. Elevated concentrations of pesticides, arsenic, and PAHs were found in the pond's sediment in summer 2000.

- *Willow Pond* is currently filled with sediment; resultant vegetative sand bars are visible above the water surface. Stormwater is contributed via the Chestnut Street Drain and from upstream discharge from Ward's Pond. Some flooding occurred in Willow Pond during the October 1996 storm. As in Leverett Pond, water quality standards for fecal coliform have not been met historically and exceeded the limits in autumn/winter 2000 as well. PAHs and lead also were found at elevated levels in Willow Pond's sediment.

Spring Pond (Natural History Pool) a unique habitat, where the rare Three-Spine Stickleback has been found.

- *Ward's Pond* is a kettle hole pond with a depth of about 4 feet and very steep slopes around its perimeter. It receives its flow contribution from Jamaica Pond, but was not flooded during the October 1996 storm. Water quality standards have been met historically, so no testing was conducted in late 2000. Only one sediment sample exceeded the TCLP lead regulatory limit.

Biological Environment

- Like all other parts of the Emerald Necklace, much of the beauty of *Leverett Pond* is marred by invasive plant colonies, such as knotweed (nearly 96,000 square feet). The same kinds of fish (e.g., Large Mouthed Bass), birds (e.g., American Crow), and wetland plants (e.g., Purple Loosestrife) that inhabit other Muddy River areas live in Leverett Pond as well.

- *Willow Pond's* surrounding area includes over 220,000 square feet of woodlands and nearly 30,000 square feet of invasive plant colonies, such as buckthorn and knotweed. A rare species of fish—the three-spined stickleback—was found to inhabit a small pool in Willow Pond.

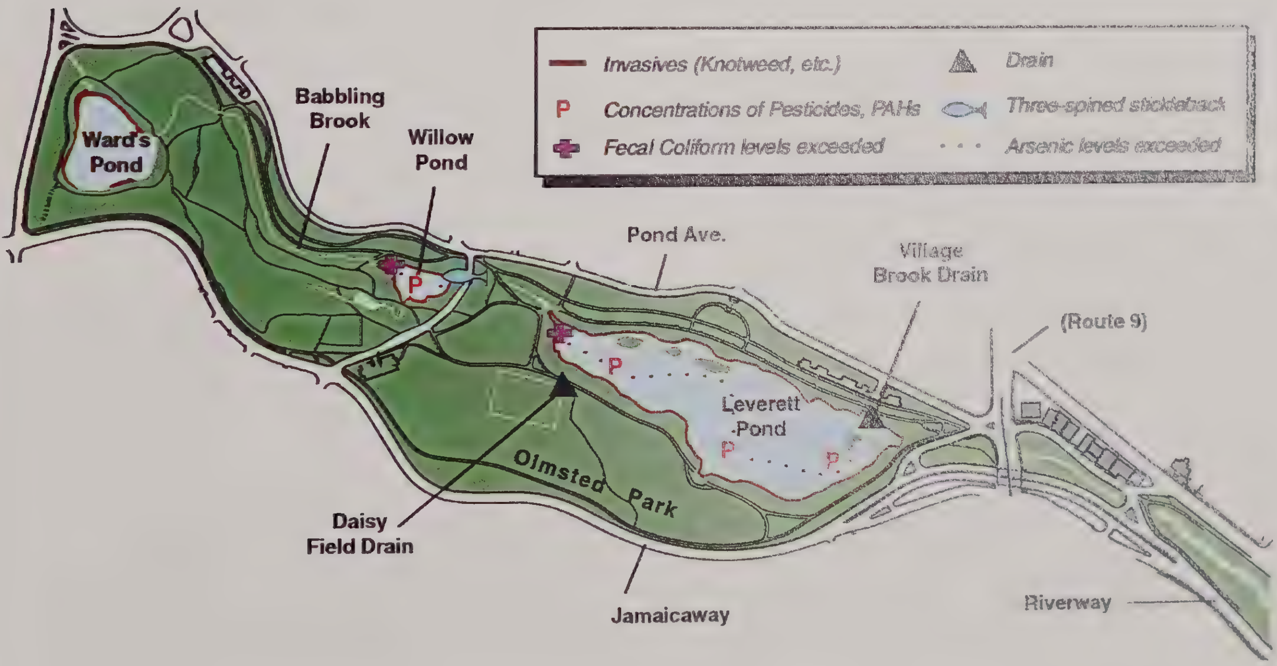
- Existing vegetation at *Ward's Pond* consists of approximately 160 trees, 850 shrubs, nearly 200,000 square feet of woodland, and more than 20,000 square feet of invasive plant colonies (e.g., knotweed). With the exception of an exotic turtle, the same species of fish, birds, reptiles, and wetland plants that live in the other ponds also inhabit Ward's Pond.

Historic Significance

Olmsted's intent for the area now known as Olmsted Park (designed and constructed between 1880-1895) was a "chain of picturesque fresh-water ponds, alternating with attractive natural groves" (from *Suggestion for the Improvement of Muddy River*, 1880). The Park (including the three ponds) was placed on the National Register of Historic Places in 1971, and designated a City of Boston landmark in 1989.

- *Leverett Pond* already existed in 1880. With Olmsted's creation of a park, the boundary between Boston and Brookline changed and several pathways were constructed for access. In the 1940s, the Boston Park Department built a baseball diamond in the meadow east of Leverett Pond (now known as Daisy Field).

- At the time of Olmsted's design, both *Willow Pond* and *Ward's Pond* were natural water bodies. Willow Pond had a small brook feeding it and a small brook outletting to Leverett Pond; Ward's Pond was fed by Jamaica Pond and connected to Willow via Babbling Brook. As with the other Muddy River parks, Olmsted designed extensive plantings to beautify the sites, and pathways and bridges to provide access to them. In 1956, MDC widened a right-of-way around Willow Pond parkland and, in 1962-63, constructed a skating rink on a parcel of land just east of the pond (the rink was removed and the area resodded in 1997). In [illegible] MDC planned to take more land by eminent domain and completely reconstruct the roadways surrounding Willow Pond and Spring Ponds. Opposed to the plan, the Town of Brookline retained ownership via a successful court battle, and the parkways were not disturbed. Ward's Pond has not been modified since the late 1890s, when pools around the pond were filled and boulder bridges demolished.



Solving the Problems

It's clear from the above summary and from the detail provided in this DEIR's Section 4 that problems abound in the Emerald Necklace. In order to preserve this national and local historic landmark and rehabilitate Olmsted's landscape, the Emerald Necklace Master Plan was developed. This project will address Phase I of the Plan by accomplishing five objectives:

- Improve flood control — reduce flooding of the residences, institutions and businesses in major storms by reducing flood elevation in the river.
- Improve water quality — reduce the level of contaminants in the river while increasing the dissolved oxygen.
- Enhance the aquatic and riparian habitat — improve the quality and diversity of aquatic and wildlife habitat in the river and along the banks.
- Restore the landscape and historic resources — implement elements of the Master Plan along the river corridor.
- Institute Best Management Practices (BMPs) — to obtain these objectives:
    - minimize re-sedimentation rates by capturing more sediment before it reaches the river, ensuring major dredging will not be required again for nearly 70 years.
    - improve water quality by reducing the volume, bacteria, nutrients, and other contaminants entering the river as runoff.
    - maintain and protect the public's investment by improved maintenance in the watershed.
    - contribute to the attainment of fishable/swimmable conditions in the Charles River, which receives the Muddy River's flow, by achieving the above objectives.

Selecting the Right Strategy to Achieve Project Objectives

A variety of alternatives were evaluated that addressed one or more project objectives. Because the project's objectives are interrelated, one alternative may advance several objectives simultaneously. Alternatives were screened by comparing the relative benefits against each other. Only alternatives that met the project objective(s) and were judged more technically suitable, environmentally advantageous, consistent with historic preservation goals and cost-efficient were selected.

Determining What Will Work

A comprehensive evaluation of dozens of alternatives has ensured that the right measures will be taken. A flow diagram of the alternatives screening process summarizes all alternatives and the criteria against which they were evaluated, shows why some were rejected and others accepted, and explains the geographical area in which they will be most useful (e.g., Back Bay Fens, The Riverway, etc.).

The Preferred Plan

Several actions judged to be technically suitable, environmentally sensitive, and cost-efficient will rehabilitate the Emerald Necklace – from dredging and infrastructure improvements to historic reconfigurations and habitat improvements to source control and treatment improvements. The preferred plan for each geographical area is outlined below and further detailed in Section 5 of this DEIR. Also, included below is a discussion of "basin-wide" BMPs, since these practices are recommended throughout the Emerald Necklace.

Preferred Alternative for Charlesgate

- Construct one staging area for dredging equipment.
- Dredge and remove 3,300 cubic yards of sediment and debris.
- Replant vegetation selected from Olmsted list.
- Rehabilitate staging areas and disturbed areas.
- Replace new pathways and lights.
- Remove waterway obstructions under Ipswich Street.

Charlesgate Area (Boylston Street to the Charles River)

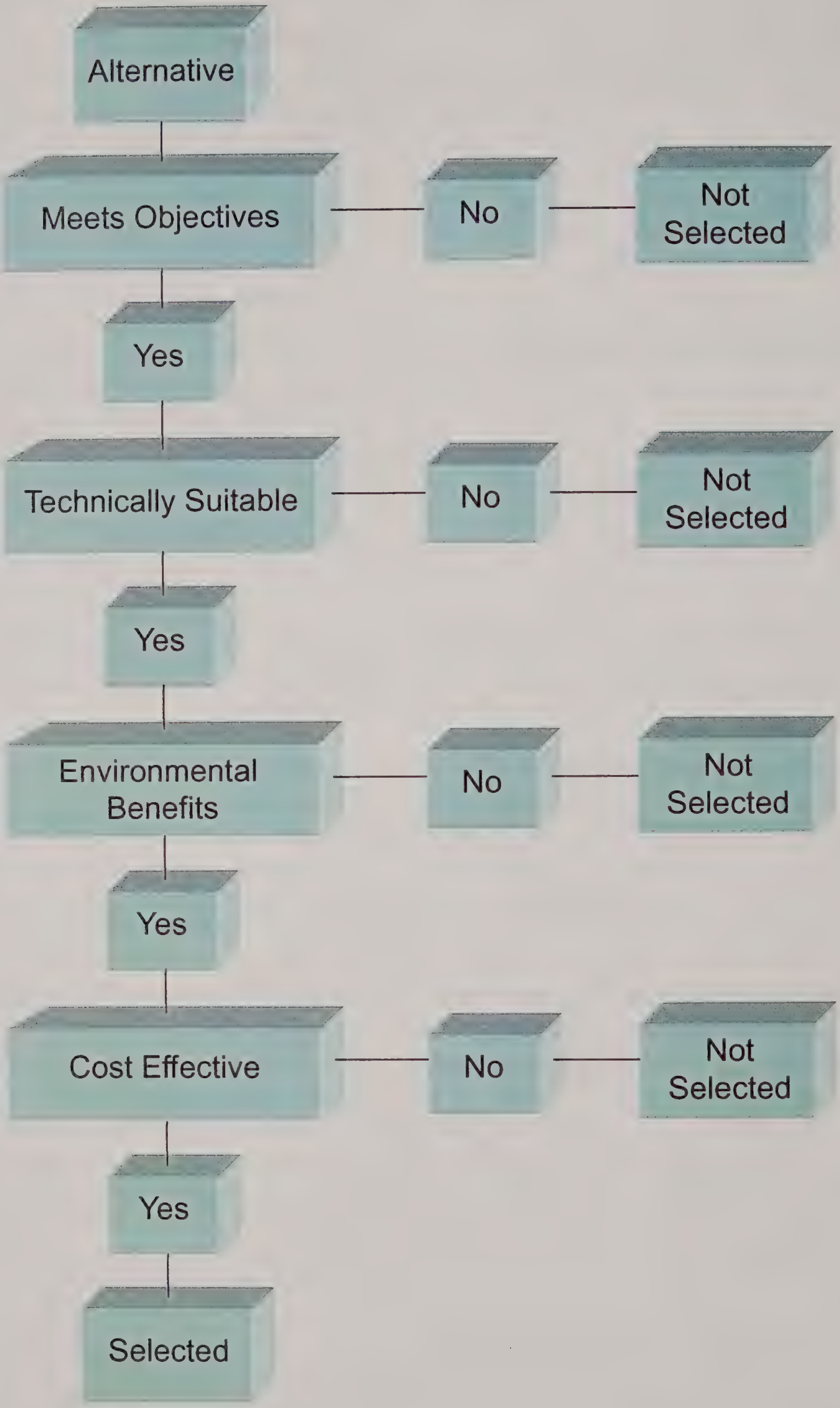
Dredging will remove approximately 3,300 cubic yards of sediment in the Charlesgate area. A staging area will be set up at Commonwealth Avenue. Trucks accessing the staging area from I-93 will follow Massachusetts Ave. to [illegible] Charlesgate West. Trucks leaving the area will follow Commonwealth Ave. to Massachusetts Ave. to I-93. Construction in the Charlesgate area will not require temporary closure of [illegible] sidewalks. The Gate, Gatehouse, and balustrade areas will be protected.

Back Bay Fens (The Riverway at the former Sears Parking Lot to Boylston St.)

Bank-to-bank dredging will include the removal of dense stands of *Phragmites*. After dredging is completed, construction of culverts and daylighting will follow. Daylighting will restore the open waterway of Olmsted's time at the former Sears parking lot and upstream at the Fens Bridge. Three construction staging areas will be set-up at Agassiz Road, the Lagoon (Jersey Street) and Fens Bridge. The construction access route for trucks coming from I-93 (Exit 18) would be via Melnea Cass Boulevard, Tremont Street, Ruggles Street, Louis Prang Street, The Fenway, Park Drive and Boylston Street. The egress route for the Lagoon and Fens staging areas is the reverse of the access route. For the Agassiz Road staging area, egress would be to Westland Avenue to Mass. Ave. to I-93. For culvert construction at The Riverway, one lane closure of The Riverway is possible providing that signal-time adjustments are made. Culvert construction across Brookline Avenue at the Sears Rotary will require a combination of night and day work using construction techniques to minimize noise generation.

Almost all the selected alternatives address several objectives at once, ensuring not only that the main issue of flood control is resolved, but also that the project is cost-efficient and environmentally and historically compatible.

After the invasives are removed, landscape rehabilitation will include both plant massing and the construction of turf-covered banks. Since the Fens is now freshwater, plant lists for the Muddy River will be used and plant massings from the historic plan documentation will guide the rehabilitation of disturbed areas. The daylighted areas will be restored and rehabilitated to reflect Olmsted's original plan.



Alternative Screening Process

Preferred Alternative for The Back Bay Fens

- Construct three staging areas for sediment dewatering equipment and truck loading at Agassiz Road, adjacent to the Lagoon (Jersey Street) and Louis Pasteur.
- Dredge and remove 96,500 cubic yards of sediment and debris.
- Daylight culverts at Fens Bridge and former Sears parking lot to Olmsted-designed shoreline configuration to the extent possible.
- Prevent future encroachment and preserve the historic shoreline by removing 23,500 cubic yards of *Phragmites.*
- Revegetate staging areas and disturbed areas using plants selected from Olmsted list to enhance habitat values.
- Construct a new 10-ft by 16-ft arch culvert under The Riverway at former Sears parking lot. Maintain the twin 72-inch diameter pipes under The Riverway.
- Construct a new 10-ft by 24-ft arch culvert under Brookline Avenue at the Sears Rotary with an overflow to the Muddy River Conduit.
- Rebuild the upstream and downstream headwalls of the Fens Bridge to historic rehabilitation standards and remove sediment from the Fens Bridge culvert.
- Create sedimentation basins by over-dredging in four locations: Sears culvert, downstream of Louis Pasteur Bridge, at the Victory Gardens, and downstream of Agassiz Road.
- Decrease the use of pesticides and herbicides in the Victory Gardens by developing a public education program on water quality impacts and alternative methods of weed and pest control.
- Create a vegetated swale near the Victory Gardens to reduce overland flow velocities and trap pollutants.
- Reconstruct curbs, gutters and storm drain systems primarily along roadways in the Fens, the Fenway, and Agassiz Road to minimize overflows onto parkland.
- Install a particle separator the end of the Emmanuel College drain. Complete design and construction by 2007.
- Evaluate possible sites for other particle separators based on the pilot study for water quality improvements.

The Riverway (The Riverway at the former Sears Parking Lot to Leverett Pond)

The Riverway will be dredged bank-to-bank and invasive plants such as *Phragmites* will be excavated. A staging area will be set-u[illegible] Netherlands Road. During construc[illegible] Netherlands Road will be closed to gene[illegible] traffic which would be diverted [illegible] Riverway and Brookline Avenue. Acc[illegible] the staging area would be from R[illegible] Brookline Avenue to Aspinwall A[illegible] Netherlands Road. Egress would [illegible] short length of The Riverway t[illegible] Avenue to Route 9.

Preferred Alt[illegible]

- Dredge 20,200 cubic [illegible] debris.
- Remove 10,000 cubic yards [illegible] species and restore [illegible]
- Revegetate staging and distur[illegible] historically based plantings [illegible] species.
- Create sedimentation basins by ov[illegible] in two locations: Netherlands [illegible] upstream of Brookline Aven[illegible].
- Reconstructing curbs and gutters and [illegible] storm drain system, to prevent bank er[illegible] along The Riverway.
- Construct one staging area at Nether[illegible] Road for sediment dewatering equipment a[illegible] truck loading.

After dredging, the original shoreline and grading will be restored to Olmsted's original plan. Areas where invasives have been removed and where banks are unstable will be rehabilitated with historically based plant massing and turf-covered banks. Two inaccessible islands near the Longwood MBTA Station will remain inaccessible as work proceeds. The existing reachable island and two bridges near Netherlands Road will remain usable. Planting will include wetland planting, bank planting, and upland planting of shrub and tree layers to improve wildlife habitat and restore the historic intent of the landscape.

Leverett Pond

Leverett Pond will be dredged bank-to-bank. A staging area will be set-up at Daisy Field using the northern softball field. The Little League field will be separated from the staging area with fencing and remain in use. Construction vehicle access to the staging area would be from Route 9 to Cypress Street to Pond Avenue to Willow Pond Road. The egress route would be the reverse of the access route. Construction will not require any temporary closure of roads, and walkways will be temporarily relocated around construction zones.

Restoration of the historic turf-covered banks on the northeast side of the pond will require restoration of an historic path to re-establish pedestrian access. Areas where invasives have been removed will be rehabilitated with plant massing and turf-covered banks. The Brookline shoreline has gabions, which will be protected and replanted with wetlands species. Three existing inaccessible islands in Olmsted Park will remain inaccessible. Invasive species will be removed from the islands. One island will be reshaped to reflect Olmsted's original plan.

Preferred Alternative for Leverett Pond

- Construct one staging area at Daisy Field for sediment dewatering equipment and truck loading.
- Dredge 23,900 cubic yards of sediment and debris including sand bar opposite Village Brook drain.
- Re-vegetate staging and disturbed areas using plants selected from Olmsted list.
- Rehabilitate historic island and shoreline stabilization where needed.
- Restore Babbling Brook at the inlet from Willow Pond.
- Create a sedimentation basin by over-dredging Leverett Pond near the Village Brook Drain.
- Re-orient the Daisy Field backstop and ball field.
- Evaluate the effectiveness of the particle separator at the Daisy Field outfall.
- Evaluate the feasibility of storm drain treatment devices (i.e., off-line underground sand filters, dry swales, etc.) in the Village Brook watershed.

Willow Pond

After dredging, the original Willow Pond shoreline and grading will be restored to Olmsted's original plan. Dredging Ward's Pond will require piping to be laid on the path above the brook between Ward's and Willow Ponds. Once this piping is removed, rehabilitation of the Willow Pond shoreline will include restoring the culvert bridge with pudding stone "teeth" and the rock bank from Spring Pond into Willow Pond. Planting will include wetland planting, bank planting, and upland planting of shrub and tree layers to improve wildlife habitat and restore the historic designed landscape.

Preferred Alternative for Willow Pond

- Use Daisy Field staging area.
- Dredge 5,900 cubic yards of sediment and debris.
- Re-vegetate disturbed areas using plants selected from Olmsted list and stabilize historic shoreline.
- Enhance the habitat of the three-spined Stickleback.
- Repair the rock dam between Spring Pond and Willow Pond.
- Reintroduce and reshape one island.
- Create a sedimentation basin by over-dredging Willow Pond.
- Evaluate the effectiveness of a particle separator in the Chestnut Street drain.

Preferred Alternative for Ward's Pond

- Use Daisy Field staging area.
- Dredge 15,600 cubic yards of sediment and debris.
- Re-vegetate disturbed areas using plants selected from Olmsted list.

Ward's Pond

After dredging, grading at the outlet will be restored to Olmsted's original plan. Existing shorelines will be protected and maintained. Access into Ward's Pond will affect an existing historic bridge that will require protection. Planting will include wetland planting, bank planting, and upland planting of shrub and tree layers to improve wildlife habitat and restore the historic designed landscape where areas are disturbed. Turf-covered bank areas will be re-established and the footbridge over the outlet will be reconstructed.

Basin-wide BMPs

- Boston Public Works Department (PWD) and MDC need to evaluate and [illegible] the effectiveness of their street sweeping programs.
- Boston Water & Sewer Commission (BWSC) is improving the tracking of catch basin sediment accumulation and adjust the frequency of cleaning accordingly through their Catch Basin Maintenance Program. Interim Progress reports have been submitted. Phase I has been completed.
- Boston Parks and Recreation Department (BPRD) and the Brookline Parks and Open Space Department (BPOSD) should address desire lines and maintain paths to prevent erosion.
- The project Proponents should jointly develop a public education program addressing issues such as litter control, clean-up after pets, and limiting the use of pesticides and herbicides.
- BPRD and BPOSD should develop a waterfowl control program and implement it. The plan should combine regulatory and actions and public education.
- Boston and Brookline should enhance their respective implementation of "pooper scooper" regulations.
- Project Proponents should conduct a pilot program on the several existing particle separators in the Muddy River watershed to determine the effectiveness of these devices.
- BPRD and BPOSD should maintain historic planting and turf area along shore line

What Can Be Done to Mitigate Impacts?

The proposed rehabilitative construction will result in the temporary disturbance of the Muddy River, public use of portions of the parklands, roadways, and pedestrian walkways (see insert). Specifically, staging areas will contain some combination of sedimentation tanks, pumps, coagulant polymer feed systems, belt filter presses, water filters, conveyor belts for truck loading, a field office, and/or limited construction parking.The former Sears parking lot will further be the site of construction activities related to construction of an arch culvert under The Riverway and Brookline Avenue. Long-term physical alterations will occur at the Fens Bridge and former Sears parking lot, where culverted sections are restored to more natural ecosystems and historic configurations.

Mitigation of construction-related impacts will be implemented in two ways:

- Contract documents will include specifications on requirements that the contractor must meet to reduce environmental impacts.
- The contractor will prepare plans for approval on how work will be conducted to limit environmental impacts. These plans include, but are not limited to, the following:
    - *Dredging and Dredged Material Management* – describes in detail the dredging operations, disposal of materials, and the methods by which the contractor will control impacts of the dredging operations.
    - *Stormwater/Dewatering Pollution Prevention Plan* – describes the method to control runoff from the construction site and methods to prevent and control releases from the construction site.
    - *Water Quality Monitoring* – specifies how samples will be collected, analyzed, and reported; also includes how quality data will be used to modify operations if needed.
    - *Traffic Mitigation Plan* – describes traffic controls to meet specified truck routes and limit impact of the construction traffic on the surrounding areas; likely to include police details, traffic light adjustments, parking restrictions, and control of contractor traffic during high impact times.
    - *Rodent Control Plan* – specifies the use of certified pest control supervisors to control pests and rodents; includes cooperation with neighboring groups affected by the work.
    - *Historic and Natural Resources* – describes the protection of historic and natural resources, including, but not limited to, structures, trees, shrubs, and other areas outside the construction limits.

A Resident Engineer and an Independent Environmental Monitor (IEM) will monitor compliance with the contract documents and contractor's submitted plans. The IEM will be part of the Proponent's construction monitoring team, but not responsible for the construction contract's commercial terms. The IEM will report violations of the mitigation measures and environmental permits to the construction management team.

Sediment Quality

Muddy River sediment consists of organic silt, fine-to-coarse sand, and gravel. At various locations along the river the sediment also contains decayed plant matter, sticks, peat, bricks, wood, glass, and pieces of concrete. Contaminated sediments will be handled according to state and federal laws and regulations. Accumulated sediments will be removed to depths ranging from one to five feet. This removal will increase river flow capacity and improve overall sediment quality.

Water Quality

Construction activities will temporarily affect the Muddy River's water quality. Runoff from the staging areas, dredging operations, and return water from the belt filter presses will increase turbidity in the river. The duration will be short, and due to the extremely low flow volume of the Muddy River, the area affected will be limited. The return water will be treated so that it is expected to contain a total suspended solids (TSS) concentration of 50 milligrams per liter (mg/1) and a maximum daily limit of 100 mg/1.

Benthic Resources

Dredging will result in a temporary loss of benthic species (e.g. worms, mi[illegible] other invertibrates), which are presently dominated by pollution-tolerant [illegible]. Some remaining benthic species are expected to a[illegible] for regrowth. However, the new community [illegible] less dominated by pollution-tolerant organisms a[illegible] water benthic species begin to proliferate.

Temporary Project Impacts

- Disturbance of park areas
- General environmental construction
- Traffic impacts
- Construction parking
- Increased turbidity
- Loss of fish
- Air quality
- Dust
- Loss of parking
- Public safety at staging areas
- Noise
- Odors
- Aesthetics

Fish Resources

It is anticipated that dredging will kill some fish. Th[illegible] loss may be proportionally higher in the bottom-dwelling species than the open-water species (the Muddy River would actually benefit from substantially fewer-bottom dwelling species). Because Spring Pond contains a rare fish species, the three-spine stickleback, no construction work will directly affect Spring Pond. The stickleback has also been found in a small pool in Willow Pond where the water from Spring Pond falls below a small stone dam. Sticklebacks in this pool will be relocated to Spring Pond and the sediment in the pool removed; the pool will then be reconstructed with clean fill (after the stone dam has been repaired) and revegetated.

Wetlands

The proposed work includes the removal of *Phragmites*, including the extensive root system. Where one species dominates the present ecosystem, several species of shoreline and emergent plants will replace it. This will result in a substantial enhancement of the functions and values of the aquatic, wetlands, and upland ecosystems as well as a commensurate enhancement in wildlife functions and values. The proposed project will result in "no net loss" of wetland resources.

Wildlife Resources

In locations where dredging occurs during winter hibernation, amphibians and reptiles will not be able to relocate and will be lost. However, after construction, the upland wildlife community will benefit significantly from the revegetated landscape that will feature a diverse plant selection from the Olmsted plant list, selected to meet both preservation and habitat goals.

Ecological Functions and Values

Dredging, invasives removal, and disturbance of construction areas will temporarily impact the current habitat's function and values. Long-term physical alterations are related to bank stabilization, deepening of the water body, reconstruction of an island, and the enhancement of the aquatic and upland ecosystems to more natural ecosystems. The replacement vegetation will benefit waterfowl and avian species as a source of food and cover. In addition, much of the emergent vegetation will provide spawning areas for fish species.

Long term, the water quality is expected to improve due to BMPs and removal of significant quantities of dredged sediment, which is preventing the river from meeting Class B water quality criteria.

Pedestrian Access

Pedestrian access during construction will be obstructed in several areas, especially adjacent to staging areas. In most cases, access will be maintained with temporary pathways. Safety barriers and signage will direct pedestrians around construction activities.

Traffic

During construction, this project will add traffic to both regional roadways providing access to the project area and to local roadways abutting the Muddy River. The majority of traffic generated by the project can be attributed to hauling dried material from the staging areas and culvert construction. The total volume of trucking in this area is not anticipated to have significant impact on the traffic volumes; however, ingress and egress to staging areas will be limited during rush hours to minimize traffic impacts. Hydraulic dredging will generate 20 truck trips per day (about 4 trips per hour) and 10 trips per day for the contractor's cars. These low traffic volumes will not significantly affect traffic at nearby intersections.

The world-class Gardner Museum is located in the Fenway neighborhood

With the proposed temporary closure of Netherlands Road for use as a staging area, and the desired regional truck route to Route 9 via Brookline Avenue, the project will affect traffic at the intersection of The Riverway and Brookline Avenue. This impact is the result of added traffic to the intersection, primarily by eliminating Netherlands Road as a bypass of The Riverway/Brookline Avenue intersection for general traffic. Finally, truck traffic to/from the Daisy Field Staging Area will be routed along Pond Avenue to Cypress Street to Route 9. This truck routing avoids several congested intersections along the Jamaicaway at Perkins Street. From the northern staging areas, vehicles will use I-93 via Massachusetts Avenue as the primary route for removing material from the site.

The greatest traffic impacts are associated with culvert construction. Automobile volume to capacity ratios indicate delays will occur during the morning and evening rush hours at the intersection of Boylston Street/Park Drive and Brookline Avenue. Culvert construction across The Riverway could be completed during the day in phases. It is possible to close one lane of The Riverway without significantly affecting traffic by modifying traffic signal timing. The Brookline Avenue culvert will require a combination of day and night construction.

Noise

During culvert construction, dewatering equipment, trucks, pile driving, sheet pile or soldier piling installation will generate noise. Culvert construction under Brookline Avenue near the former Sears parking lot will include a combination of day and night work due to the difficult traffic conditions at the Sears Rotary. Work at either end of the culvert can be constructed during the day since sufficient space exists in adjacent park areas for mobilization and work areas. Unless construction of the culvert across Brookline Avenue is done at night, new, temporary lanes [illegible] will result in significant traffic impacts. The following noise mitigation measures will be undertaken:

- The regulation for the Control of Noise in the City of Boston will be followed during construction activities. This regulation restricts noise to 65 decibels (dBA) in a business zone at all times except for the operation of certain construction equipment, which is limited to 80 dBA. Similarly, the Town of Brookline will require the contractor to adhere to the Town's ordinance governing operating hours.

- On a weekly basis, the contractor will measure noise levels. Should noise levels exceed the allowed limit measured at locations indicated in the regulations, the contractor will take steps to reduce noise to levels acceptable to the Resident Engineer and responsible municipal officials.

- All construction equipment will be fitted with suitable mufflers and similar noise abatement devices prior to receiving approval to commence work.

- Drilled piling techniques will be used to reduce noise levels when installing foundation piles. Sheet piling will use vibrating driving equipment to reduce noise levels. Where foundation piles and sheet piling work cannot be done on weekdays due to traffic volumes, the work hours will be limited to stop by 11:00 PM or on weekends when traffic is lighter.

Signage

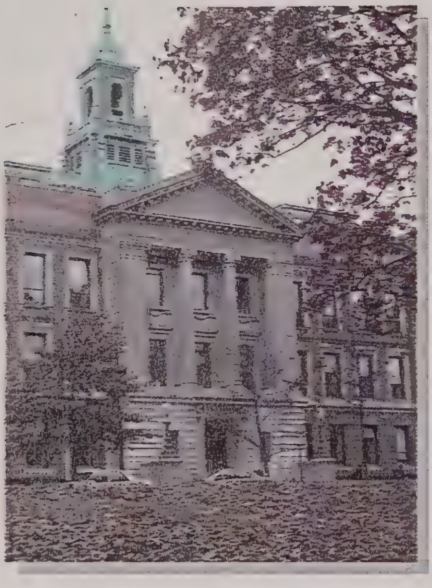
The project area should have interpretive signage.

Satisfying Regulatory Requirements and the Public

Following the Rules

MEPA

As noted earlier in this Executive Summary and further elaborated on in Sections 3 and 9 of this DEIR, the ENF for the Muddy River Project was submitted to the Executive Office of Environmental Affairs (EOEA) in January 1999. The Secretary of Environmental Affairs issued two certificates on the ENF on April 29, 1999—one for the EIR's scope and requirements and the other establishing a Special Review Procedure to accommodate an expanded public involvement process. This Draft EIR is expected to be submitted in January, 2002. Given typical allowances for regulatory review, the Final EIR is currently anticipated to be submitted in late 2002 with a final certificate issued by MEPA in early 2003.



Simmons College in the Fenway

In addition to the details of the Special Review Procedure (i.e., the designation of a Citizens' Advisory Committee (CAC), the certificate also requires Annual Updates documenting physical improvements, management practices, and information regarding current environmental conditions gathered through monitoring. The first Annual Update is anticipated to be filed one year after Charlesgate construction commences, probably during the last quarter in 2002. The Annual Update will allow local, state, and federal agencies and the public to comment on several project issues:

- Monitoring program results.
- BMP implementation.
- Dredging and other rehabilitative work.
- Work successes and shortcomings.
- Modifications to procedures to enhance work success.
- Future plans for additional work not covered in the EIR.

Project Advocates and Their Role

Project advocates include a group of public/private stakeholders with a common interest in restoring the Muddy River: Boston Parks and Recreation Department (which serves as the lead agency and is a Proponent) and the Town of Brookline (Proponent). Several other agencies and entities also have actively supported the project: The Emerald Necklace Conservancy, U.S. Army Corps of Engineers (ACOE), Massachusetts Department of Environmental Management (DEM), Massachusetts

EOEA, MDC, Federal Emergency Management Agency (FEMA), and Massachusetts Emergency Management Agency (MEMA).

In November 1999, a Memorandum of Understanding (MOU) among local proponents and state agencies involved in the project was executed. Its purpose is to facilitate cooperation among the respective authorities in project planning, permitting, funding, and implementation. The MOU allows for the transfer of funds between participating parties, provides commitments for adherence to all applicable regulatory or programmatic requirements, and summarizes Phase I financial commitments from the participants.

Other Regulatory Requirements

Regulatory requirements applicable to the Muddy River Project include the Massachusetts Wetland Protection Act (WPA) (Massachusetts General Law [MGL] Chapter 131, Section 40 and its regulations, as well as Chapter 91 and its regulations), Section 106 of the Federal Historic Preservation Act, and Section 404(b)(1) of the Federal Clean Water Act (CWA). This project will require two sets of permits: one for the proposed Charlesgate work, and one for the remaining project components (i.e., Back Bay Fens, The Riverway, and Olmsted Park and its waterways).

- The Wetlands Protection Act has eight statutory interests upon which the regulations are built. Each wetland resource area (i.e., bank, land under water, bordering vegetated wetland, riverfront area), as defined by the WPA regulations, is presumed to serve one or more of these interests. This project will be conducted under the "limited project" provisions (310 CMR 10.53) as allowed under the regulations. The local conservation commissions and the Department of Environmental Protection (DEP) share responsibility for enforcing WPA provisions. Orders of Conditions must be granted by both the Boston and Brookline Conservation Commissions.

- Historic properties are those that either are listed or are eligible for listing on the National Register of Historic Places. Section 106 of the National Historic Preservation Act requires that every federal agency "take into account" how each of its undertakings could effect historic properties. The agencies are required to work with the State Historic Preservation Officer (SHPO) and the Advisory Council on Historic Preservation. Any proposed work in the park must be reviewed by the Boston Landmarks Commission,Brookline Preservation Commission with the Massachusetts Historical Commission (in accordance with MGL Ch. 9 Sec. 26-227C as amended by Chapter 254 of the Acts of 1998). In addition, the Boston Landmarks Commission has independent review and approval of work in the Boston sections of the Emerald Necklace.

- This project will require a CWA Section 404(b)(1) permit or otherwise be a project sponsored by the ACOE. An important standard that applies under 404(b)(1) is that dredged or fill material should not be discharged into an aquatic ecosystem unless it can be demonstrated that such a discharge will not have an adverse impact on the ecosystems of concern. A Water Quality Certification also is required for the discharge of dredged material into Commonwealth waters, which require federal licenses or permits and which are subject to state water quality certification under CWA Section 401. Through this certification, DEP ensures compliance with Surface Water Quality Standards.

- A Chapter 91 Waterways permit (MGL 310 CMR 9.40) must be obtained before dredging and dredge disposal activities can occur.

Orders of Conditions

Orders of Conditions specify the type and extent of work that is permitted, not only under Phase I, but also for succeeding phases. By statute, an Order of Conditions is limited to a three-year period with extensions granted upon request. Given the complexity of the Muddy River project, it is likely that a five-year duration (three years plus two one-year extensions) will be requested. Due to the potentially variable nature of rehabilitation and other work that may take place in resource areas in subsequent years, the Orders of Conditions are likely to contain a requirement that the Proponents appear before the Conservation Commissions each year immediately following the filing of the MEPA Annual Update. Once the Secretary of Environmental Affairs issues the Certificate on the Annual Update, the Conservation Commissions may then issue amendments to the original Orders, as necessary. This is the mechanism by which the Conservation Commissions will be able to review and approve of any continuing rehabilitation within the resource areas.

Required Permits

- EIR Certificate from the Secretary of EOEA.
- Dredging permit under CWA Section 404 from the U.S. ACOE.
- Dredging permit under MGL Chapter 91 from DEP.
- Orders of Conditions from the Boston and Brookline Conservation Commissions.

Listening to Public Concerns

The CAC

Project success depends upon open communication and active involvement with the public, including individuals, community groups, environmental associations, educational and cultural institutions. To facilitate this communication, in 1999 the EOEA Secretary appointed 29 individuals representing a wide range of interest groups to serve on a CAC. The CAC's mandate was to review proposed activities, comment on the feasibility of different approaches and the likely environmental impacts, and assist the Proponents in generating and reviewing alternatives that would avoid or minimize damage to the resource. Since September 1999, the CAC has met 32 times with the project Proponents on a wide range of EIR topics. More detail can be found in Section 3 of this DEIR.

Other Communication Measures

On November 8, 2000, a Public Meeting was held summarize the project, and on December 2, 2000, the Proponents briefed the Fenway Garden Society. Technical Advisory Group meetings were held weekly starting in September 1999, and numerous meetings were held with other agencies to expand the sphere of communication and outreach. Meetings with MDC, Boston Transportation Department, Town of Brookline, BWSC, and Boston PWD were held to discuss traffic issues and how to better implement BMPs.

Boston and Brookline committed early in the project to develop a Pre-Application Review Committee (PRC) to improve the flow and timeliness of information to the permitting agencies. Sixteen people representing a wide range of state and local government formed the PRC and attended four meetings.

- On April 25, 2000, discussions focused on a project overview, the permitting process, and the sampling and analysis plans to characterize water column and sediment quality.
- On October 20, 2000, the PRC participated in a field trip to review project alternatives, newly completed wetland delineations, wildlife habitat, [illegible] bank disturbance and restoration areas, and dredging methodologies.
- On December 7, 2000, discussions focused on historical and landmark [illegible]
- On March 14, 2001, the PRC met to review the DEIR's project elements and potential environmental and historic preservation overlaps in regulations.

September 1998 Site Walk with the Boston and Brookline Conservation Commissions

Protecting the Investment

Here's the Plan

Upon completion of Phase I, nearly $100 million will have been spent from federal, state, local, and private sources (see the next section, "Cost and Schedule Estimates"). To ensure this investment is protected, a Management and Maintenance Plan must be in place. This Plan must identify the management, staffing, equipment, and procedures needed to sustain the Phase I dredging, daylighting, revegetation, establishment of BMPs, and other related construction.

Specific Plan Goals

- Ensure the success of the Muddy River Project's five objectives: flood control, improved water quality, enhanced aquatic and riparian habitat, historic rehabilitation, and BMP implementation.
- Incorporate and adapt management and maintenance procedures for improved parkland.
- Identify specific problems/issues relating to maintenance operations and develop strategies to deal with them.
- Prepare a prioritized list of projects to be undertaken in the parks.
- Explore available management and maintenance resources and use them optimally.
- Assure that key parties (e.g., CAC, ENC) are involved and develop an ongoing forum for sustained communications.
- Develop a realistic schedule and standards for maintenance activities, addressing concerns of an assemblage of stakeholders.

Maintenance Activities and Resources

To maintain park assets such as lawns, trees, shrubs, walkways, benches, and other amenities as well as ancillary project aspects such as culverts, water quality, and BMPs, higher standards are necessary (e.g., additional resources for horticultural care, specialized crews for woodland maintenance, an effective mowing program, erosion control, etc.). Maintenance needs differ in each area (e.g., woodlands have different needs than parklands or river banks) and between existing park areas and new plantings, which will total 215 new trees and 24.5 acres of shrubs, wetland plants, perennials, and lawn. The chart on the page 29 describes the activities needed to meet these higher standards.

Current versus Future Maintenance Resource Needs

A detailed evaluation of current resources working in the Emerald Necklace parks revealed that between Boston, Brookline, and MDC staff, total productive time spent on maintenance activities is approximately 16,536 hours per year. To meet the higher standards recommended in this DEIR, each municipality or entity will need to provide additional staff. Details of this summary are summarized in Section 8. The Draft Maintenance Study itself is included as Appendix J. The proponents concur that the additional maintenance effort summarized in Section 8 will protect the capital investment in this unique resource. In order to close the gap, strategies include improved organization, training, better defined maintenance tasks, hiring staff, increased use of volunteers and an increased rolefor public-private partnerships.

Pest and Rodent Control

Over the past several decades, the Muddy River parks have seen an increase in duck and geese migration, in general, and more specifically, due to the abundance of food from persons feeding them. The presence of these birds has denuded the ground cover and imparted large quantities of bacteria to the water and sediments. Proactive

Park Area	Recommended Routine Maintenance
Shrubs, perennials (planted areas)	Watering, fertilizing, mulching, pruning, pest control, winter protection, use of ground covers; identify erosion frequently and plant to control future erosion.
Turf	Mowing, watering, fertilizing, liming, aeration,turf renovation, weeding; identify erosion frequently and plant turf to control future erosion.
Water Bodies	Remove trash, water-borne vegetation, and invasives growth; monitor water quality.
Invasives	Initial large-scale removal: dredging, excavation, cutting, and hand-pulling; thereafter, a combination of cuffing, hand-application of state-controlled herbicides, and hand removal.
Trees	Pruning, fertilization, and damage protection (must have staff trained in this area).
Site Furnishings	For benches, repair, replacement, and painting. Empty trash cans, replace lights and maintain light poles, maintain drinking fountains, and remove graffiti.
Woodlands	Remove invasive species, re-establish the under story area and plant additional trees where canopies need to be filled in; maintain trials and control erosion.

maintenance measures to reduce the number of ducks and geese in the River include public education, local ordinances against feeding wildlife, planting of suitable plant species to form a barrier between the water and land, and implementation of reproductive and [illegible] biological controls by state and federal game [illegible].

Monitoring and Inspections

To ensure that Plan improvements are maintained, the Plan includes recommendations for monitoring water/sediment quality, planting and invasives control, fish/wildlife resources, and preservation of historic character. These are discussed briefly below and further detailed in Section 8 of this DEIR.

- Water/sediment quality - conduct an annual water quality sampling program consisting of quarterly (seasonal) sampling events. Collect samples during a dry period, during precipitation, and the day following precipitation. Analyze the samples for several parameters as illustrated below. Water/Sediment Quality Sample Locations and Parameters

- Plantings/invasives - inspect the site at one, three, and five years after plantings and invasives removal to assess results and adjust future plantings as required. Continue monitoring program on a three-year cycle to ensure the health of subsequent plantings. For invasives, following initial removal, use mechanical cutting, hand-application of herbicides, and hand removal to maintain control.

- Fish/wildlife - every two years, a biologist should visit the site several times in the early and late growing seasons to document wildlife use of the habitat. Documentation will help fulfill the regulatory requirements and add to the scientific database on the Muddy River biological community.

- Historic character - inspect parks annually to evaluate historic preservation methods and adjust maintenance efforts (character- and defining-features to be monitored are listed on page ES-31).

Water/Sediment Quality Sample Locations and Parameters

Within the Muddy River

Ipswich Street
Agassiz Road
Boston Gate Houses
Fens Bridge
Longwood Avenue Bridge
Outlet of Levereff Pond
Outlet of Willow Pond
Outlet of Wards Pond

Drainage Outfalls

Emmanuel College Drain
Longwood Avenue Drain
Tannery Brook Drain
Huntington Avenue
Village Brook Drain
Daisy Field Drain
Chestnut Street Drain

Sample Parameters

Fecal Coliform Bacteria
Fecal Streptococcus Coliform Bacteria
Total Suspended Solids (TSS)
True and Apparent Color
Total Phosphorus
Orthophosphate Phosphorus
Turbidity
Alkalinity
Acidity
Ammonia Nitrogen
Nitrate-Nitrite Nitrogen
Metals
TPH-EPH

Best Management Practices (BMPs)

BMPs, used to ensure effectiveness and reduce the need for future capital costs, are recommended for structural improvements (e.g., new culverts), source control (e.g., erosion prevention and catch basins), and treatment controls (e.g., vegetated swales). Maintenance for each of these BMPs is discussed below and further detailed in Section 8 of this DEIR.

- Structural - maintenance involves cleaning/inspection at regular intervals. Specifically, for new culverts, remove accumulated debris or sediment and repair structures; clear blockages when discovered; annually, inspect culverts for structural integrity.

- Source Control - some examples of maintenance for these BMPs include annual inspection of adjacent roadways and curbs, continual updates of the catch basin database and regular catch basin cleaning, augmentation of street sweeping program and regular maintenance of equipment, replanting of grass/ vegetation along trials every spring and fall, and implementation of an ongoing public education program.

- Treatment Control - for vegetative swales, regular mowing, monthly inspection to check for erosion, and prompt reseeding of damaged areas; every five years, scrape swale bottoms and remove sediment to restore original cross-section and infiltration rate. For particle separators, conduct seasonal inspections for first year of operation; thereafter, clean system annually. For sedimentation basins, monitor sand bar formation annually.

Specific Storm Events

Such routine maintenance, monitoring, and inspection as described above must be supported by specific preventative and corrective measures following a large storm event.

- Preventative - prior to large storms, conduct a site walkthrough to identify and remove trees or debris blocking culverts or bridge openings.

- Corrective - inspect and immediately clean catch basins to remove sediment deposited by the storm; rehabilitate eroded stream banks and pedestrian trials; and remove debris such as fallen tree branches and litter.

To manage flooding, a major emergency action plan was developed with the cooperation of all interested parties. The plan includes four stages: Alert, Warning, Operation, and Cessation of Event. Specific activities involved in each stage are outlined in Section 8.

Accountability and Management:

The City of Boston and Town of Brookline will share responsibility for implementing the Maintenance Plan summarized above and further detailed in Section 8. They will use the following tools to prove their commitment and ensure long-term project success.

- Memorandum of Understanding - commits the proponents to funding maintenance in return for state assistance in capital expenditures.
- Quality Assurance Program - logs/ monitoring reports will document that the project is meeting its objectives.
- MEPA Annual Updates (AUs) - these updates will inform the Secretary of Environmental Affairs and public of project progress; the CAC will review the draft AU 30 days prior to submission to MEPA, ensuring their continued contribution.
- Guidance from state agencies on activities that require permits - for example, Department of Army Permit under Section 404 of CWA, Permit to Dredge under MGL Ch. 91 from DEP, etc.; see earlier section of Executive Summary for a detailed list of permits.

Historic- and Character-Defining Features (as defined by the National Park Service) To Be Inspected Annually

- Spatial relationships
- Views and vistas
- Topography
- Circulation systems and site entries
- Vegetation
- Water features
- Furnishings and structures

While Boston and Brookline are ultimately responsible for the parks' rehabilitation, a park management structure will ensure consistent oversight of park areas and advocacy to support and provide the resources to maintain these areas over the long-term. Following are possible alternatives for an initial management structure. As with other successful park management structures, this initial framework will evolve over time. More detail on each alternative is provided in Section 8.

Description	Frequency of Reporting	Responsible
Update Maintenance Operations Plan	Annually	Management Group
Maintenance Logs	Annually	Maintenance Supervisors
BMP Monitoring/Maintenance Logs	Annually	Maintenance Supervisors
Pest Control Programs	Annually	Management Group
Water Quality Monitoring Program	Annually	Management Group
Report on Plantings	Years 1,3,5 Every 3 yrs after	Horticulturist
Report of Aquatic and Wildlife Distribution	Bi-Annually	Management Group/Biologist
Report on Historic/Character Defining Features	Annually	Management Group/ Landscape Architect

Summary of Monitoring and Inspection Program

- Existing Management Structure (status quo) - Currently, Boston, Brookline, and the MDC each maintain a portion of the Emerald Necklace park area and are responsible for its maintenance; although there is increased cooperation and collaboration among the partners, no one entity coordinates the park crews to ensure consistency, or that work is conducted according to a specific set of standards.

- Cooperative Management Structure - Under this structure, Boston, Brookline, and MDC would continue to maintain their respective park sections, but would do so in concert with a unified plan. One representative from each entity (commissioner or director level) would cooperatively set policy and goals for park maintenance and BMPs. Assisting this group would be horticulturists, arborists, and maintenance supervisors or operations managers.

- Public/Private Partnership - These types of management structures can take many forms; research into other park systems revealed that such partnerships usually take the form of a conservancy leading the organization with the public entity providing portions of staffing and funding. Currently, the Emerald Necklace Conservancy (ENC) is active, but is nonetheless a relatively young and growing organization. As the ENC matures over time, it may well generate the resources and funding other successful park Partnerships enjoy.

- Entity Under the Environmental Joint Powers Act - To facilitate intergovernmental action on natural resource and environmental issues, Massachusetts' law allows two or more public agencies to enter into an agreement to jointly exercise jurisdiction and responsibilities over specific areas. A local example is the Upper Mystic River Watershed Agency - nine communities who have formed an agency to address flooding problems. One weakness of such an agency concerns funding (its member communities are not obligated to provide funding). If the agency's work is limited to coordinating actions and expending study funds, it can be successful; however, if more ambitious projects are conducted, annual appropriations may become problematic.

- Park Commission or Authority - Massachusetts' law also allows commissions or authorities to be formed to lead an organization dedicated to a specific public purpose. The actual organizational structure can vary significantly, but, in simple terms, a commission or authority is a central organization with a structure separate from the towns/cities involved. Sources of funding are a weakness of this kind of structure, since the parks are generally not revenue generating entities, an appropriation from the owning agencies, or outside funding, must be obtained. Therefore, a successful park authority or commission is only possible with sufficient political support in the member communities to cede control of park areas and secure adequate funding streams.

Irrespective of which alternative is selected, it should consider using several resources, such as the ENC, community councils, the CAC, and volunteers.

Paying the Bills

Capital Budget

The projected cost of the Muddy River Restoration Project is approximately $91.1 million (see Section 10). Subtracting the $7 million (which, in part, includes early action on Charlesgate) allocated to the project, the remaining capital funds needed amount to roughly $84 million. This budget will include the design and construction of the remainder of the project (upstream of Charlesgate) and the capital costs for the treatment control or "structural" BMPs in the watershed.

A funding strategy for the additional capital costs has been formulated involving federal, state and municipal funding. The U.S. Army Corps of Engineers has been authorized by the Congress in the Water Resources Development Act of 2000 (WRDA2000) to undertake the Muddy River project for flood damage reduction and environmental restoration. Also, the Commonwealth of Massachusetts has committed to provide significant capital funding. The municipalities of Boston and Brookline, having been partners with the state and federal agencies in funding the first $7 million, are committed to obtaining capital funds to supplement the federal and state sources. Finally, the City of Boston and the Town of Brookline, co-proponents, in partnership with the Commonwealth will explore other potential federal, state and local funding sources to supplement the major funding sources.

Getting Started

Construction Phasing and Schedule

Construction phasing of the project (see Section 5 for details) will be dependent on the sources of funding and timing of when funds can be appropriated and obtained.

Funding for the Charlesgate portion of the project has been secured and the project has been designated by the Secretary of Environmental Affairs to proceed if sufficient information is included in the DEIR to address the environmental issues. The Charlesgate portion of the project includes dredging in the Charlesgate area and removing several obstructions under bridges between Boylston Street and the Charles River. Bidding is expected to start in the Spring of 2002 upon receipt of the Secretary's certificate for the Draft EIR. Construction should be completed by late 2002.

Construction phasing for planning purposes on the remainder of the Phase I Project is currently assumed to be a single construction project. Under these circumstances, the bidding is not expected to occur until the Secretary issues a Certificate on the Final EIR.

Anticipated Muddy River Phase I Construction Schedule	
Bid Charlesgate	Spring 2002
Start Charlesgate Construction	Summer 2002
Complete Charlesgate Dredging	End of 2002
FEIR Certificate	Early 2003
Bid Muddy River	Early 2003
Start Muddy River Construction	2003
Complete Muddy River	2006

Assuming a Certificate on the Final EIR is issued in early 2003, the bidding could begin in the winter of 2003, with construction commencing in 2003 and completion anticipated in 2006. This schedule is dependent on the appropriation of federal, state and municipal capital funds.

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Section One

Section 1
Introduction

The Phase 1 Muddy River Flood Control, Water Quality and Wildlife Enhancement, and Historic Preservation Project ("the project") involves a multidisciplinary approach to improving the Muddy River system, adjacent parkland, and other areas that are part of what is referred to as the Emerald Necklace, located in Boston and Brookline, Massachusetts. Components of the project are derived from previous engineering and historical studies of the project area including the Emerald Necklace Parks Master Plan ("the Master Plan") by the City of Boston and Town of Brookline, and flood control studies by the Army Corps of Engineers (ACOE), the Executive Office of Environmental Affairs (EOEA), and the Federal Emergency Management Agency (FEMA).

Proponents of the project include a group of stakeholders with a common interest in restoring the Muddy River: Boston Parks and Recreation Department (which serves as the lead agency), the Town of Brookline, the Massachusetts Department of Environmental Management, and the Boston Water and Sewer Commission . Several other agencies and entities also have actively supported the project, including The Emerald Necklace Conservancy, the ACOE, the Massachusetts Department of Environmental Management, EOEA, the Metropolitan District Commission, FEMA, and the Massachusetts Emergency Management Agency (MEMA).

Such a diverse group of project advocates and supporters need to build consensus and coordinate their efforts for the project to be successful. By using a public process that includes a Technical Advisory Group (consisting of Federal, State and local personnel), a Pre-Application Review Committee made up of regulators and a Citizens Advisory Committee (appointed by Secretary of the Executive Office of Environmental Affairs), all stakeholders can contribute to the project. Additional public outreach through public information meetings and speaking opportunities further broadens project input. Lastly, the organization of the Emerald Necklace Conservancy provides private support to the project.

Project Area The project area, located in Boston and in Brookline (see Figure 1-1, Site Locus), is surrounded by a variety of land uses including arterial roadways, educational and art institutions, medical facilities, residential development, and more. The Emerald Necklace Master Plan covered the park network from Back Bay to Jamaica Pond. The Phase I Muddy River Flood Control, Water Quality and Wildlife Enhancement and Historic Preservation Project covers only the Muddy River watershed, defined as the area beginning with the Muddy Rive confluence with the Charles River, and extending 3.5 miles upstream to Wards Pond (see Figure 1-1). The Muddy River watershed has a drainage area of 5.6 square miles, with about 65% in Brookline, 25% in Boston, and 10% in Newton.

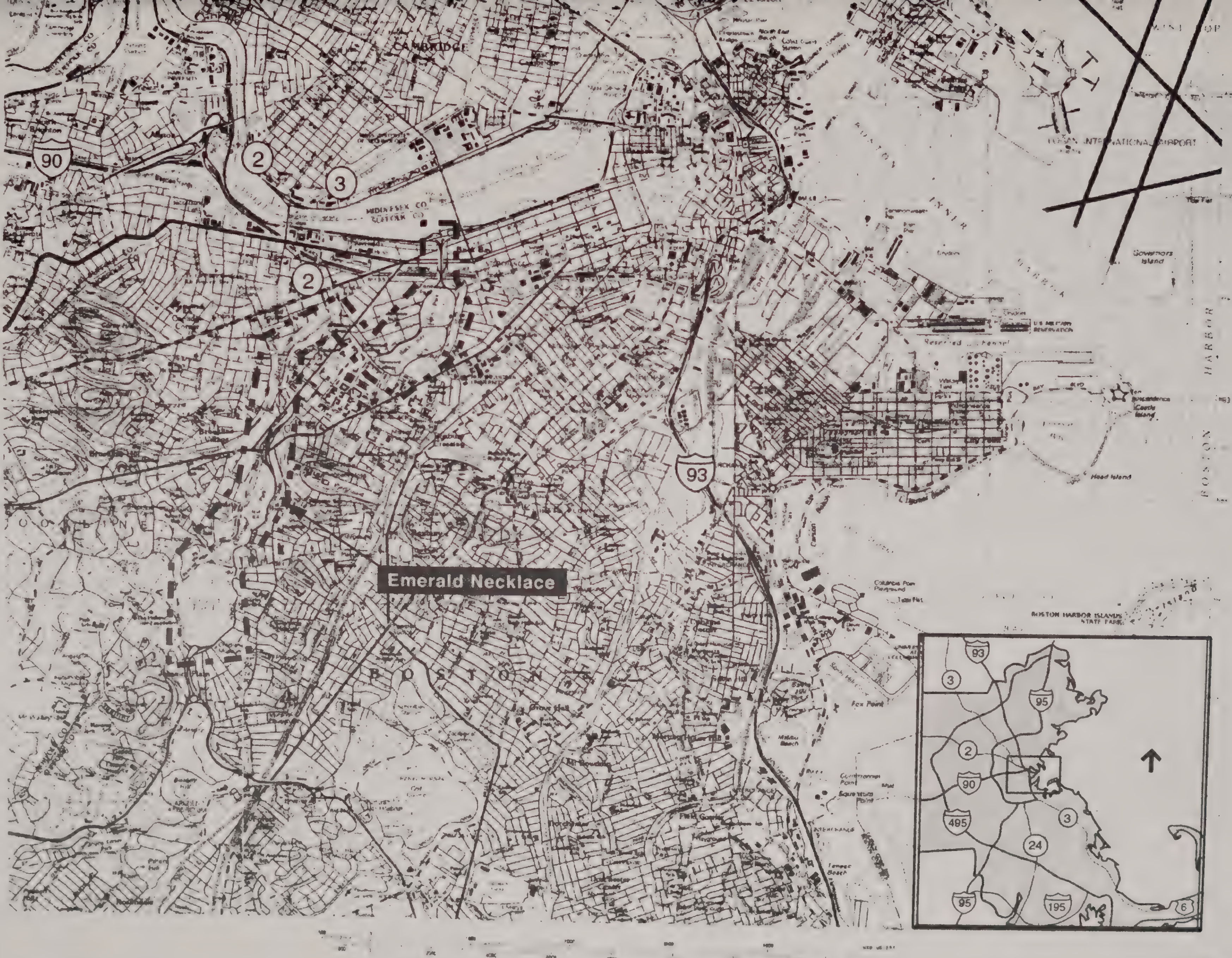


Figure 1-1
Site Location

Problem Definition   Since its creation around the turn of the twentieth century, the Emerald Necklace in general, and the area surrounding the Muddy River in particular, have been subject to the effects of gradual yet extensive urbanization. As the populations of Boston and Brookline grew, they brought with them the attendant expansion of buildings, roadways, traffic, and congestion. The results of development on the watershed have been significant. Flooding has worsened because there is little natural storage left in the widely paved watershed, and sediment and debris have washed into the river, choking off flood carrying capacity. Water quality has deteriorated as an array of natural and man-made compounds are carried off the land surface during rainstorms and deposited into the river. Non-native invasive species of flora such as *Phragmites* and knotweed have overtaken portions of the river, pushing out native species, creating safety hazards, eliminating natural habitats and greatly limiting the diversity of wildlife that can live within the watershed. The distinctive landscape designed by Frederick Law Olmsted has declined in richness and diversity, the present landscape lacking the subtlety and coherent massing of plant materials that once characterized the original landscape. The parks in the Emerald Necklace are a designated Boston Landmark and are listed in the National Register of Historic Places. The Muddy River and the associated parks have extremely high societal value and are within walking distance of many prominent institutions, cultural landmarks, and neighborhoods.

Project Objectives   As shown in Figure 1-2, Project Objectives, the project is designed to meet a number of objectives. Each objective is included to address specific problems that have developed over time and/or to maximize the benefits to be derived from the proposed improvements. The following summarizes the problems to be addressed. Section 1.8 provides a more detailed discussion of project objectives.

Provide Flood Control   In October 1996, the Muddy River flooded as a result of a storm that deposited 5.45 inches of rain in a period of 24 hours, and incurred damages estimated at $63M for the Muddy River, the MBTA and Stony Brook Conduit. (Damage estimate provided by the US Corps of Engineers for public damages. FEMA reported alternative avoided damages between $74 and $117 million including public and private damage.) Analyses conducted subsequently show that the 1996 storm flows overwhelmed the Muddy River capacity as a result of the increase in impervious area within the watershed over time, and constrictions in flow capacity caused by inadequate culvert sizes where the Muddy River has been culverted under the former Sears parking lot. The encroachment of invasive species and the deposition of sediment also has reduced the flood-carrying capacity in certain sections of the channel. The project will improve flood control. Figure 1-3 illustrates the extent of flooding experienced in October 1996 provided by the Department of Environmental Protection (DEP).

Improve Water Quality Urban runoff and storm drain discharges have resulted in sedimentation, increased turbidity, and other contaminants have contributed to water quality degradation experienced along some portions of the Muddy River. Stabilizing banks where needed, and implementing other measures (such as over dredging and

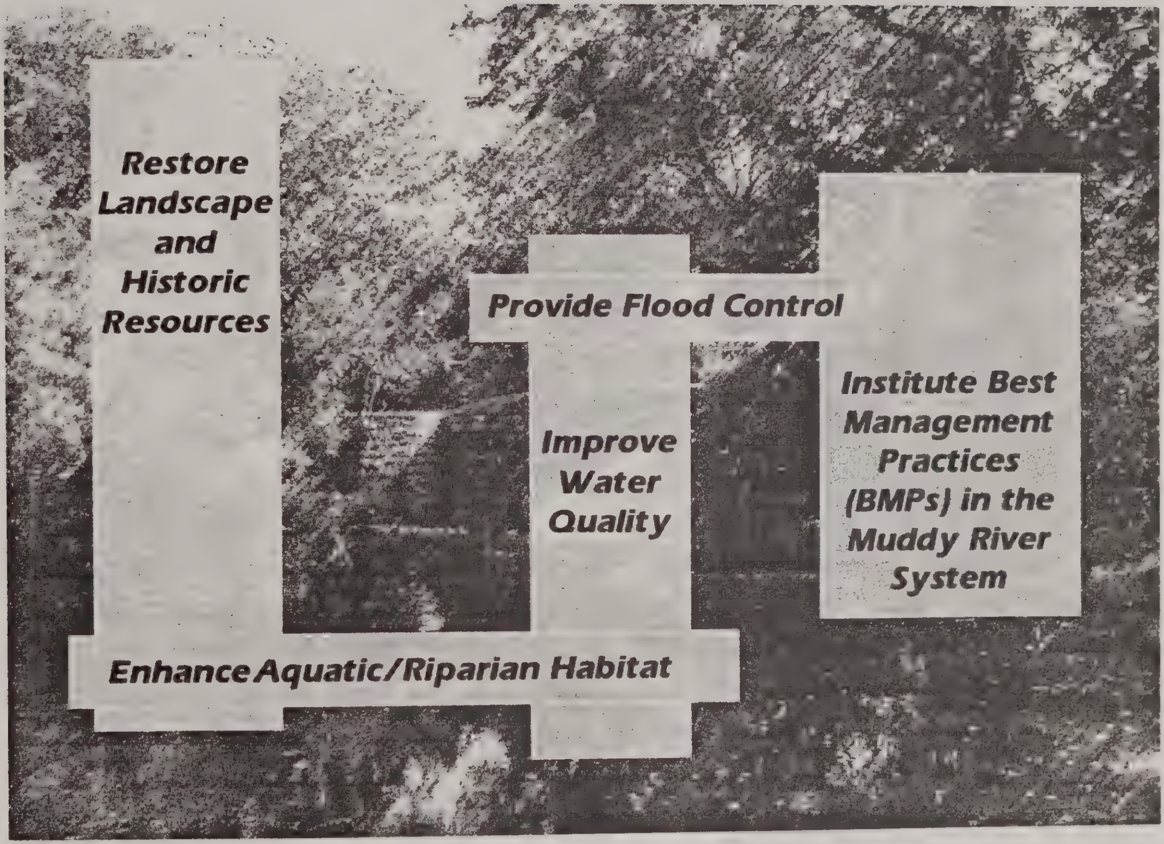

Restore Landscape and Historic Resources
Provide Flood Control
Institute Best Management Practices (BMPs) in the Muddy River System
Improve Water Quality
Enhance Aquatic/Riparian Habitat

Figure 1-2
Project Objectives

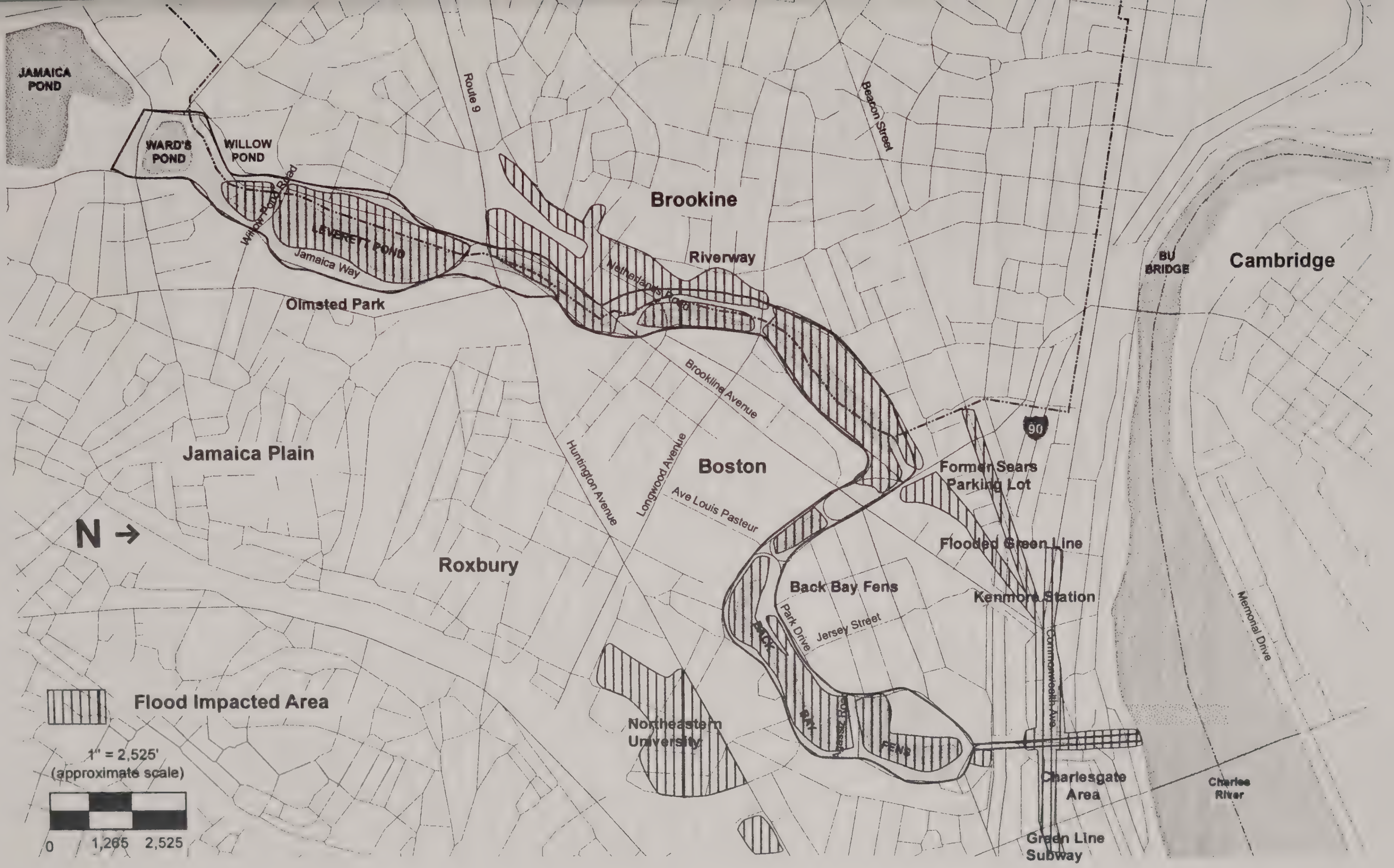


Figure 1-3
Aerial Extent of Flooding, Oct. 1996
Source: CDM/DEM

instituting Best Management Practices), are intended to address the water quality problem in the Muddy River.

Enhance Aquatic and Riparian Habitat Much of the sediment in the river is contaminated with compounds typically found in urban environments (e.g., metals). Removal will result in improved aquatic habitat. Reconstructing or replanting historic islands will also improve the aquatic and riparian habitat. In addition, the replanting plan for disturbed riparian areas entails providing a diverse habitat and where appropriate, replacing invasive species that have overtaken certain areas with a variety of plantings to provide improved wildlife habitat.

Institute Best Management Practices in the Muddy River System Since 1898, the Muddy River has been dredged approximately every thirty years as a result of cyclical sedimentation accumulation. The implementation of Best Management Practices (BMPs) is intended to maximize the life span of the improvements for the other project objectives, i.e., flood control, water quality, habitat enhancement, and historic resources. BMP's will be an integral component of the overall plant to protect the public's investment in this valuable resource.

1.1 Historical Background

The Emerald Necklace Park system is comprised of a series of parklands and vehicular parkways, a significant number of which are linked by the elements of the Muddy River system: The Back Bay Fens, The Riverway, Leverett Pond, Willow Pond, Wards Pond, and Jamaica Pond. All of these water bodies and wetlands are central features of the Emerald Necklace System. Designed by the country's most famous landscape architect, Frederick Law Olmsted , and his associates during the last two decades of the nineteenth century, the Emerald Necklace has great historical significance as his most ambitious undertaking involving landscape architecture, metropolitan planning and engineering. In particular, Olmsted transformed the Back Bay Fens and Riverway sections, creating entirely new landscapes by dredging and filling, supplemented by nearly complete revegetation in order to create new and original scenery. He also employed the civil and sanitary engineering needed to make the watercourses functional and protected against flooding. Into these spaces he introduced a complex system of walks, bridle paths, and carriage drives to facilitate movement through the city and to provide for recreational enjoyment of the scenery.

The Emerald Necklace is the last great urban park system that Olmsted planned during a remarkable forty-year career that also spawned the design and construction of Central Park in New York, Prospect Park in Brooklyn, Washington and Jackson Parks in Chicago, Belle Isle Park in Detroit, the park on Mount Royal in Montreal, and multi-park systems in Buffalo, Rochester N.Y., and Louisville, Kentucky.

Of Olmsted's many accomplishments, the Emerald Necklace system is considered the most complex, integrated, and cohesive system of large and small parks and parkways providing green space connections between numerous and varied neighborhoods.

Listed on the National Register of Historic Places, Olmsted's Emerald Necklace parks are a preeminent example of the late nineteenth-century American Parks Movement that grew out of the need for improved quality of life in expanding urban and industrial centers that were faced with deteriorating social and sanitary conditions. The Emerald Necklace also was unique in its multipurpose functions-- improving sanitary conditions and flood control, while serving as an educational resource and an active and passive recreational resource for the City and Town.

Over time, as a result of the changes in adjacent land use patterns associated with urbanization and the lack of adequate park maintenance, water quality, hydraulic capacity, the quality of both aquatic and riparian biota, as well as historic aesthetic integrity, all have become compromised. The City of Boston, Town of Brookline, and the Commonwealth each have an interest in cooperatively addressing needs for improvements throughout project area, consistent with prior studies which include the Master Plan and various engineering studies focussed on flood control and water quality enhancement.

1.2 Components of the Master Plan

The Emerald Necklace Parks Master Plan was prepared in 1989 by Walmsley, Pressley Joint Venture and updated in 2001 by Pressley Associates Inc. The Master Plan represents a plan for the preservation and long range management of the four parks that constitute the Muddy River chain of parks of the Emerald Necklace- Jamaica Pond, Olmsted Park, The Riverway and the Back Bay Fens, designed by Frederick Law Olmstedin the period from 1878 to 1895.

History, physical conditions, contemporary uses and existing management and maintenance are discussed in the Master Plan. A vision is set forth for recovering Olmsted's original concept of a unified system of linked parks in the Master Plan. General and specific system-wide recommendations are presented under six headings: Watercourse; Internal Circulation; Parkways; Landscape Composition; Uses, Structures and Facilities; and Management and Maintenance. Several of the recommended elements have been completed or are ongoing. A copy of the Master Plan is included in Appendix A.

The Master Plan project elements summarized in Table 1-1 reflect proposed improvements concerning flood control, water quality and habitat enhancement, and historic preservation. Table 1-1 provides a brief description of the Master Plan components and an indication as to whether it will be accomplished in Phase 1. Project elements are listed geographically from the downstream end of the project advancing upstream. Consistent with the organization of this DEIR, the project elements are described in segments which include The Charlesgate Area, The Back Bay Fens Area, The Riverway, and The Olmsted Park (i.e., Leverett Pond, Willow Pond, and Wards Pond). Project elements not included in Phase 1 (e.g., proposed activities at Jamaica Pond, Arnold Arboretum, and Scarborough Pond), also are listed in Table 1-1.

Segment		Description	Phase 1	Other
BACK BAY FENS	**Watercourse**	Remove invasive aquatic vegetation and selectively plant shade trees to inhibit the further growth of nuisance aquatic vegetation.	■	
		Recreate open watercourse in front of Emmanuel College.	■	
		Flood Control	■	
		Implement Flood Warning System		■
		Conduct Charles River Dam Repairs		■
		Eliminate Structural and other Flow Restrictions	■	
		Dredge a Flood Control Channel	■	
		Remove Sediment Islands	■	
		Water Quality	■	
		Undertake Water Quality Monitoring		■
		Improve Water Quality		■
		Restructure Water's Edge	■	
		Restore Historic Gatehouse		■
	Charlesgate Area	Provide pedestrian/bike connection to the Charles River via pedestrian bridge.		■
		Recreate river edge with plant massing.		■
		Facilitate circulation by adding a bridge across the Muddy River.		■
	Mother's Rest	Repair Play Equipment (completed)		■
		Relocate Fire Department Communication Center and parking where feasible		■
		Plant formal trees along Commonwealth Avenue.		■
		Restore to open space.		■
		Restore scenic views to northern basin.		■
		Facilitate circulation by adding a bridge across the Muddy River and adding stairs to Boylston Street (completed).		■
	Victory Gardens	Pull back the Victory Gardens from the parkway and Water's edge (completed).		■
		Restore landscape surroundings.		■
		Allow Gerald Flynn Memorial Botanical Garden (completed).		■
	Park Drive	Restore scenic views into park, no shrubs in island.		■

Table 1-1
Emerald Necklace Master Plan Elements

Segment		Description	Phase 1	Other
BACK BAY FENS (CONT.)		Strengthen formal parkway plantings (urban edge) and informal (island).	■	
		Improve drainage, increase curb settings, and implement Best Management Practices (BMPs).	■	
	Ranger Station	Restore the Duck House at the Agassiz bridge and use as a ranger station.		■
	Agassiz Bridge	Restore Agassiz Bridge and associated historic plantings (completed).		■
	War Memorial	Facilitate the preservation of the War Memorial and improve related pedestrian circulation (completed).		■
		Plant perimeter with canopy trees.		■
		Replant around War Memorial to blend into park landscape.		■
	Rose Garden	Preserve Rose Garden and improve related pedestrian circulation.		■
		Plant perimeter with canopy trees.		■
		Install irrigation system.		■
	Clemente Field	Rehabilitate Clemente Field House and develop program (being removed).		■
		Remove interior bleachers – open up vista.		■
		Relocate ball courts when field house is operational.		■
	Fenway South	Redirect Muddy River flow through the Fens.	■	
		Maintain conduit to divert water and prevent flooding.	■	
		Pursue vigorous historically appropriate plantings to selectively buffer and open up views.		■
		Eliminate left turn loop which functions poorly – open water channel to maintain park continuity.		■
		Reconfigure intersection at Sears parking lot.		■
		Improve drainage, increase curb settings, and implement BMPs.		■
	Bike/Jog Path	Provide bike/jog path on east and south sides of park.		■
	Westland Avenue Entrance	Restore landscape and formalize boundaries and circulation behind the Fire Department Communications Center.		■
	Evans Way	Restore scenic intent – selectively plant new canopy trees.		■
		Improve pedestrian circulation and connections at historic entrances		■
		Construct missing bridge		■

Segment		Description	Phase 1	Other
BACK BAY FENS (CONT.)		Repair and stabilize erosion.	■	
THE RIVERWAY	**Watercourse**	Remove invasive aquatic vegetation and selectively plant shade trees to inhibit further growth of invasive aquatic plant species.	■	
		Flood Control		
		Implement Flood Warning System	■	
		Eliminate Structural and other Flow Restrictions	■	
		Dredging of a Flood Control Channel	■	
		Clean Muddy River Diversion Conduit		■
		Survey and Restore Existing Flood Control Berm		■
		Water Quality		
		Monitor Water Quality	■	
		Improve Water Quality	■	
		Restructure Water's Edge	■	
	Sears Park	Recreate historic landscape and watercourse in the area presently occupied by the Sears parking lot.	■	
		Reconfigure intersection at Sears parking lot.		■
	Back Bay Yard	Stabilize Back Bay Yard buildings and retain for maintenance facility.		■
	Carlton Street Bridge Area	Restore Carlton Street pedestrian bridge over the MBTA tracks and re-establish pedestrian access.		■
	Chapel Street Bridge Area	Restore bridge and scenic shelter (completed).		■
		Recreate bridge landscape using Olmsted planting lists and plans (ongoing).		■
		Selectively clear invasive vegetation to recreate views from bridge and improve security.		■
		Improve pedestrian and handicap connection from Longwood MBTA stop.		■
		Install historic lighting fixtures at the Chapel Street Bridge between Longwood MBTA stop and hospital area.		■
	Bike/Jog Path	Build bike path along east edge of park upon route of former bridle path.		■
	Riverway	Strengthen formal parkway plantings (urban edge) and informal (park edge).		■

Table 1-1
Emerald Necklace Master Plan Elements (Cont.)

Segment		Description	Phase 1	Other
THE RIVERWAY (CONT.)		Improve drainage, increase curb settings, and implement BMPs.	■	
		Introduce historic light fixtures.		■
	Longwood Bridge Area	Recreate bridge landscape using Olmsted planting lists and plans.		■
		Improve pedestrian circulation on Boston side of Longwood Bridge by adding steps.		■
		Selectively clear invasive vegetation to create views from bridge.		■
	Netherlands Road	Close Netherlands Road and bridge to vehicular traffic.		■
	Water Edge at Island Bridges	Remove invasive aquatic vegetation and stabilize banks with appropriate plantings.	■	
		Recreate ornamental shrub massing and meadow scenery at water edge utilizing historic views and planting plans.		■
		Plant new occasional trees that overhang for scenic effect.		■
	Riverway Island Area	Recreate landscape on island using Olmsted planting lists and plans.		■
	Riverway South	Resurface and reconfigure existing internal park circulation from Netherlands Road to Huntington Avenue to reclaim usable park land.		■
		Selectively remove invasive vegetation – restore scenic effect.	■	
		Improve drainage, increase curb settings, and implement BMPs.	■	
		Improve sidewalk on Longwood Avenue bridge (Boston/Brookline).		■
OLMSTED PARK	**Route 9 Area**	Synchronize traffic signalization to facilitate safe crossing by pedestrians and cyclists to reclaim usable park land.		■
		Reinstate scenic views on the Boston side.		■
		Reinstate scenic views on the Brookline side (ongoing).		■
		Complete the restoration of the historic inlet.		■
		Dredge and maintain the integrity of the scenic Islands in Brookline (ongoing).	■	
		Repair pond edges on the Boston side.	■	
		Inspect/repair gabion system (ongoing).		■
		Improve MDC outfall from the Jamaicaway (completed).		■
		Implement BMPs for drainage at sediment island.	■	
	Back Bay Yard	Renovate and retain as maintenance facility (completed)		■

Segment		Description	Phase 1	Other
OLMSTED PARK (CONT.)	**Bike/Jog Path**	Build bike/jog path along Boston side of park upon route of former bridle path (completed).		■
		Build bike/jog path along Brookline side of park upon route of former bridle path (completed).		■
	Path System	Upgrade and restore path system throughout the park.		■
	Jamaicaway (all MDC)	Strengthen formal parkway plantings (urban edge) and informal (park edge)		■
		Improve drainage, increase curb settings, and implement BMPs	■	
	Riverdale North from Willow Pond Road to Washington Street (Route 9)	Reinstate historic plantings on islands to maximum Extent using Olmsted lists and plans.		■
		Reconfigure intersections at both ends of Riverdale at Pond Avenue.		■
		Rehabilitate surfacing, drainage, and introduce historic lighting (underway).		■
		Define bike/jog lane and parallel parking bays (Willow Pond Road – Route 9) (underway).		■
		Restore Allerton Overlook (underway).		■
		Improve drainage, increase curb settings, and implement BMPs.	■	
	Daisy Field Area	Reorient Daisy Field ball diamonds and paint light Poles to reduce impact on park and lighting on neighbors.	■	
		Selectively clear-restore scenic views through Daisy Field to Leverett Pond.		■
		Limit Vehicular access. Provide parking off Willow Pond Road for ball players (completed).		■
		Improve field drainage and install BMPs.	■	
	Willow Pond Area	Cleanup/dredge Pond and waterways.	■	
		Maintain and plant occasional new trees that overhang for scenic effect (Boston and Brookline- ongoing).		■
		Selectively plant berry-bearing shrubs for increased wildlife value.		■
		Access the restoration of the natural history pools.		■
		Provide parking on Willow Pond Road (completed).		■
	MDC Rink Area	Reinstate open meadow at MDC rink site (completed).		■

Table 1-1
Emerald Necklace Master Plan Elements (Cont.)

Segment		Description	Phase 1	Other
OLMSTED PARK (CONT.)	**Riverdale South from Chestnut Street to Willow Pond Road**	Rehabilitate Parkway – Limit access to bikers, joggers, and pedestrians – remove vehicular access (completed).		■
		Restore the Babbling Brook.	■	
		Improve drainage, increase curb settings, and implement BMPs.	■	
		Remove guardrail on Riverdale and Willow Pond Road and Replace with more historically sensitive materials		■
	Ward's Pond Area	Remove invasive vegetation.		■
		Restore pond.		■
		Reinstate historic plantings on slopes utilizing historic views.		■
		Assess the reconstruction of the natural history pools.		■
		Refurbish historic waterfalls, bridges, and Babbling Brook.		■
		Restore existing bridges, stairs, and recreate additional bridges to restore scenic quality and facilitate circulation.		■
		Recreate new bridges (two bridges).		■
		Recreate scenic shelter.		■
		Resolve seepage across pathway and construct pedestrian walkway Over the area (completed)	■	
JAMAICA POND	**Water Control**	Replicate wetlands taken for the pedestrian walkway (no wetlands taken)		
		Control water level by repairing outflow control (completed).		■
	Play Field Area	Reorient ballfield to reduce impacts on the landscape.		■
		Remove hazardous play structure (completed).		■
	Perkins Street	Reconfigure Perkins Street to regain space for dual pedestrian and bike/jog system.		■
		Create pedestrian crosswalks at the corner of Chestnut and Perkins Streets (completed).		■
		Install silt separator (completed).		■
	Pinebank	Restore Pinebank and develop full program.		■
		Rehabilitate stairs.		■
		Re-create scenic shelters (two shelters).		■

Table 1-1
Emerald Necklace Master Plan Elements (Cont.)

Segment		Description	Phase 1	Other
JAMAICA POND (CONT.)		Control vehicular access and improve pedestrian access (completed).		■
		Retain theater (completed).		■
	Inlet and Bridge	Re-establish inlet.		■
		Build pedestrian bridge as originally planned.		■
	Pond Edge	Stabilize pond edges (continuing).		■
		Selectively remove invasive vegetation – restore scenic effect.		■
		Plant occasional new trees that overhang for scenic effect.		■
		Selectively plant berry-bearing shrubs for increased wildlife value.		■
	Boat House	Rehabilitate boat house with additional programming and environmental education center (completed).		■
	Bandstand	Stabilize bandstand (completed).		■
		Continue boat-renting program.		■
	Jamaicaway (all MDC)	Strengthen formal parkway (urban edge) and informal (park edge).		■
		Improve drainage, increase curb settings, and implement BMPs.		■
		Introduce historic light fixtures.		■
	Parkman Memorial Landscape	Selectively clear-remove invasive materials and restore scenic views to the Memorial .		■
		Rehabilitate meadow.		■
		Build new walks to access Memorial.		■
	Prince Street/ Parkman Drive	Reconfigure Prince Street/Parkman Drive to allow for bike/jog path.		■
	Bike/Jog path	Create upper perimeter loop around pond for bicycles and joggers.		■
	Park Land	Selectively remove invasive vegetation-restore scenic effect.		■
		At edge, introduce new plants to increase plant species diversity.		■
	Kelley Circle all MDC)	Reconfigure intersection to add land to the park and improve vehicular circulation to the Arnold Arboretum.		■
		Regain historic character of the (traffic) islands.		■
	Arborway (all MDC)	Improve pedestrian crosswalk connections to the Arnold Arboretum.		■
		Strengthen formal parkway plantings.		■
ARNOLD ARBORETUM	**Watershed**	Institute BMP's.		■

Table 1-1
Emerald Necklace Master Plan Elements (Cont.)

Segment		Description	Phase 1	Other
ARNOLD ARBORETUM (cont.)	**Bussey Brook CSO**			■
SCARBOROUGH POND	**Peters Hill Drainage Residential Flooding**			
	Access Improvements	Pedestrian/Golf Cart Bridge		■
	Pond Restoration	Institute BMP's		■
		Dredging		■
		Improve Water Quality		■

Table 1-1

1.2.1 Project Phasing

Each of the improvements discussed in this report can be categorized as being associated with dredging, infrastructure improvements, BMP's, wetlands restoration/bank stabilization, and historic landscape improvements. Dredging, infrastructure improvements and BMP's are proposed primarily as flood control and water quality improvement measures. Project elements falling into the other of these categories are intended to ensure the long-term effectiveness of the flood control and water quality improvement measures and to preserve the historic integrity of the Emerald Necklace.

The timing and duration of the Master Plan project elements will be determined by funding availability and environmental constraints. However, as previously proposed in the ENF, a general phasing plan consists of the following:

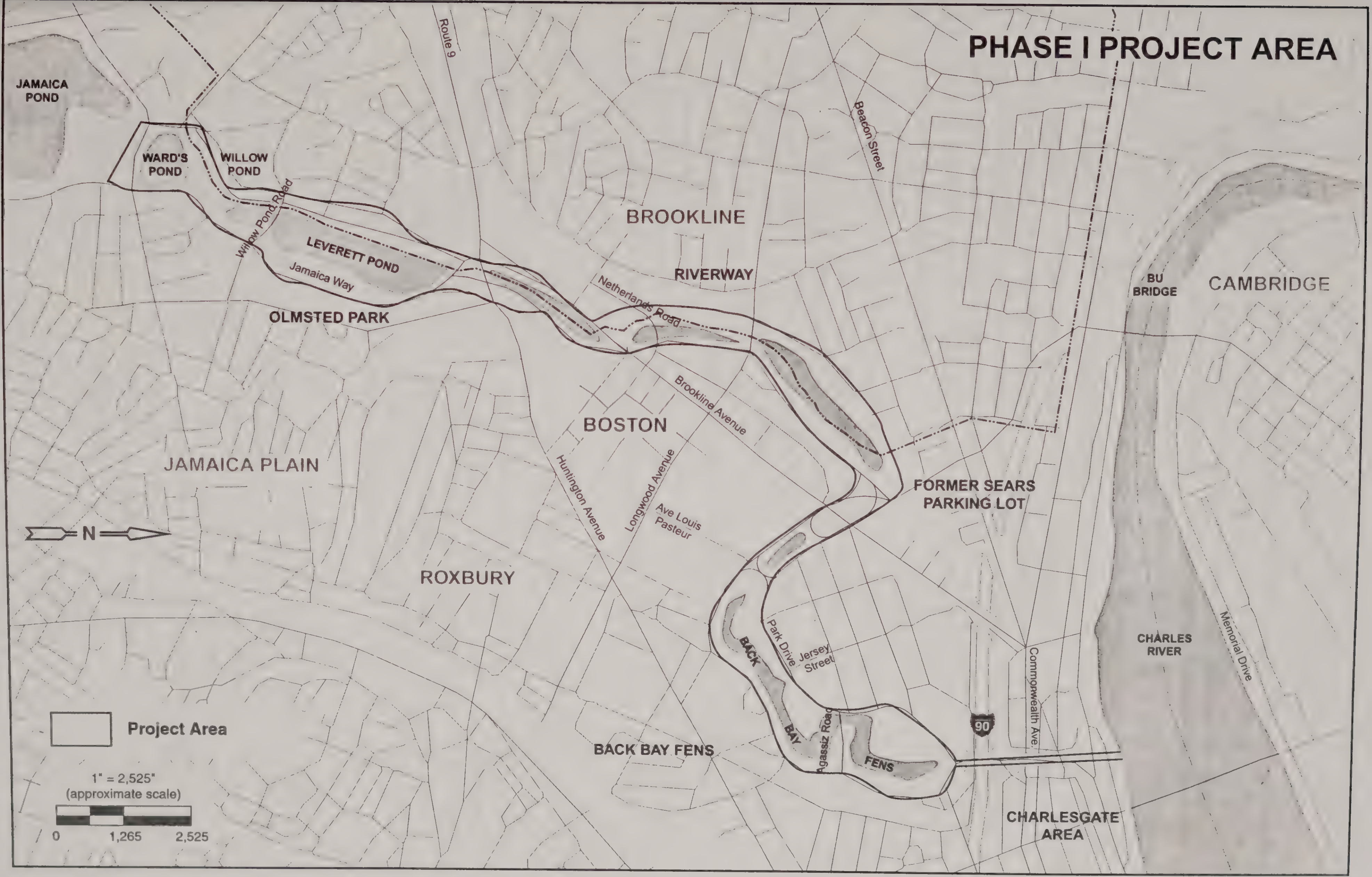
Phase I -	Muddy River Dredging, Flood Control, Water Quality Improvements, Aquatic/Riparian Habitat Enhancement, Historic Restoration, and Best Management Practices
Phase II -	Historic Landscape Improvements, Revegetation, Traffic Circulation Improvements, Building and Bridge Restoration.
Phase III -	Traffic Circulation Improvements, Building and Bridge Restoration.
Phase IV	Jamaica Pond, Arnold Arboretum, Scarborough Pond, etc.

This DEIR focuses primarily on Phase I project elements, while it also addresses a process for review of subsequent phases. The phase I elements have been further divided into:

IA-	Charlesgate Area (Boylston Street to Charles River)
IB-	Muddy River (Wards Pond to Ipswich Street).

Sections of Phase I of the Muddy River Project are depicted in Figure 1-4. Generally, implementation of elements within these geographic sections of the project will occur subsequent to the approval of the Final Environmental Impact Report. An exception relates to Charlesgate improvements, which are a subset of Phase 1. Authorization is being sought for Charlesgate activities to proceed subsequent to the review of this DEIR. Elements not identified as part of Charlesgate or Phase 1 will proceed based on funding availability, regulatory approvals and submission of an impact assessment in the MEPA Annual Update.

Phase 1 implementation approach involves riverbank stabilization, replanting wetlands and implementing landscape improvements in concert with the construction sequencing of flood control and other structural improvements.



Source: CDM

Figure 1-4
Phase I Project Area

CDM Camp Dresser & McKee Inc.

By doing so, areas that are disturbed for construction or dredging activities may benefit from landscape improvements earlier than other segments of the project. All landscape improvements, (e.g. lawn plantings, specimen tree and shrub plantings) and improvements to buildings/light fixtures etc., will be performed after all heavy equipment has been removed from the site(s), thereby offsetting any resultant damage during the construction process.

1.3 MEPA Review Procedures

The Massachusetts Environmental Policy Act Unit (MEPA) is the agency of the Commonwealth with responsibility for environmental impact review. Projects that require certain state approvals, that meet or exceed impact-related thresholds, and/or that require state funding are subject to review under MEPA. The extent of the process can vary depending on the project, but common to all projects is a requirement for public disclosure and comment.

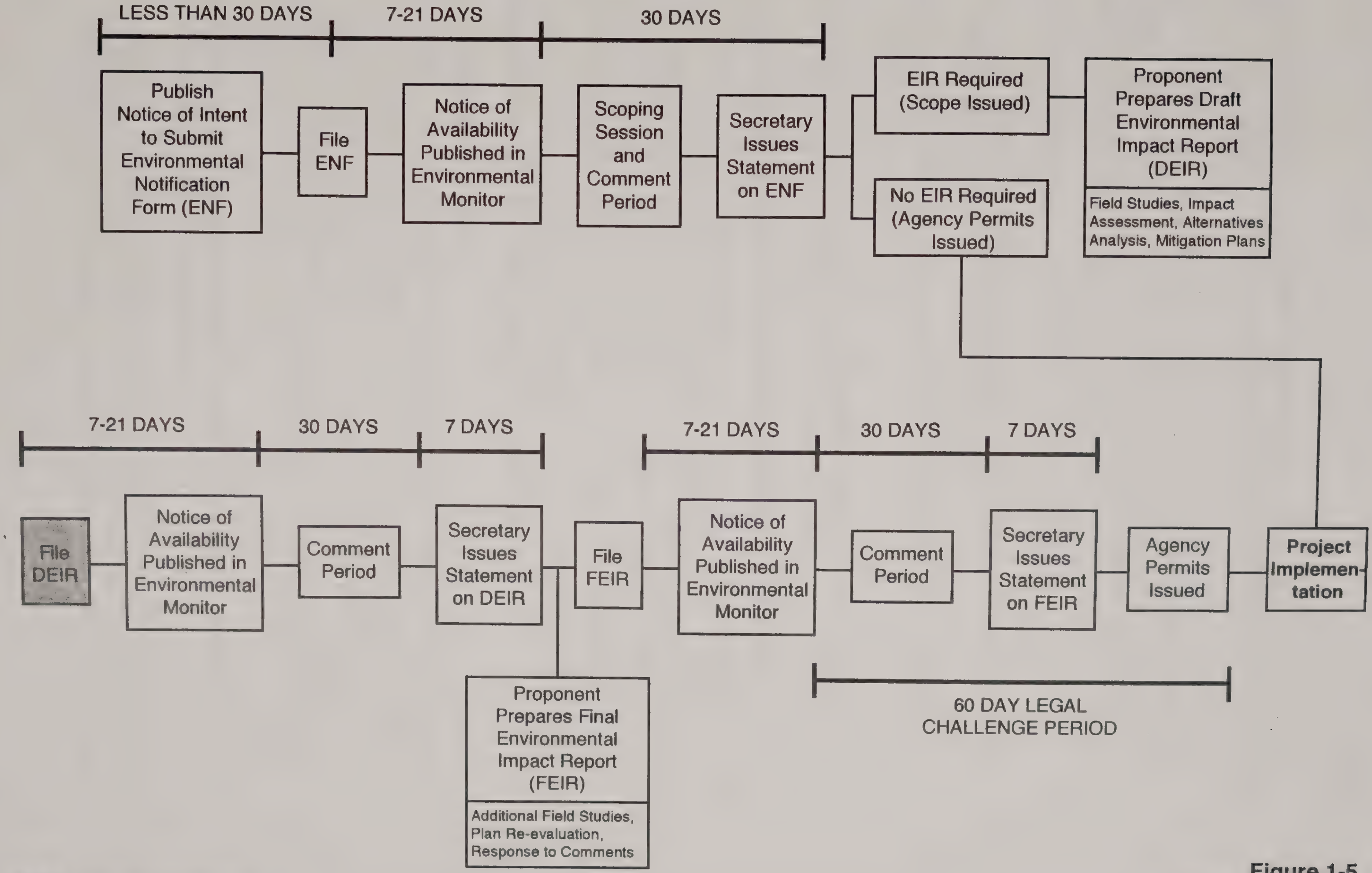
The typical review process commences with the filing of an Environmental Notification Form (ENF). After a 30-day public review process the Secretary of Environmental Affairs issues a determination regarding the need for further study (i.e., an Environmental Impact Report or EIR) and a scope for such work where it is deemed necessary. A Draft EIR is prepared, reviewed publicly, and evaluated in a Certificate issued by the Secretary at the close of a 37-day review period. The Draft EIR Certificate becomes a scope of work for the Final EIR that specifically addresses commitments to implement mitigation measures or other measures to avoid or minimize impacts from the project. The Final EIR also undergoes a 37-day review period. The Final EIR review period also comprises part of a 60-day challenge period that must expire prior to the issuance of any required state approvals.

Figure 1-5 summarizes typical stages in the MEPA process. For the Muddy River Project, the ENF was submitted to the state in January 1999. The Secretary issued two certificates on the ENF on April 29, 1999, one for the scope and requirements for the EIR, the other establishing a special review procedure. Current planning entails filing the Draft EIR in January 2002. Given typical allowances for regulatory review, the Final EIR is planned to be filed in the spring of 2002. For the Muddy River Project, the typical MEPA process has been modified slightly, at the proponents' request, to accommodate an expanded public involvement process as described below.

1.3.1 Special Review Procedures

MEPA also allows for the creation of a special review procedure for projects where the typical ENF, Draft EIR, and Final EIR review process does not provide the best planning mechanism. According to MEPA Regulation 11.09, project proponents may request a special review procedure where "... a proposed program, regulations, policy, or... [p]roject [may involve] more than one [p]roponent or more than one [p]articipating [a]gency with a significant role, or a [p]roject that is undefined or is expected to evolve during MEPA review, or a project that may benefit the environment if there is early [c]ommencement of a portion of the [p]roject."

MASSACHUSETTS ENVIRONMENTAL POLICY ACT (MEPA) PROCESS


LESS THAN 30 DAYS
7-21 DAYS
30 DAYS
Publish Notice of Intent to Submit Environmental Notification Form (ENF)
File ENF
Notice of Availability Published in Environmental Monitor
Scoping Session and Comment Period
Secretary Issues Statement on ENF
EIR Required (Scope Issued)
No EIR Required (Agency Permits Issued)
Proponent Prepares Draft Environmental Impact Report (DEIR)
Field Studies, Impact Assessment, Alternatives Analysis, Mitigation Plans
7-21 DAYS
30 DAYS
7 DAYS
7-21 DAYS
30 DAYS
7 DAYS
File DEIR
Notice of Availability Published in Environmental Monitor
Comment Period
Secretary Issues Statement on DEIR
File FEIR
Notice of Availability Published in Environmental Monitor
Comment Period
Secretary Issues Statement on FEIR
Agency Permits Issued
Project Implementation
Proponent Prepares Final Environmental Impact Report (FEIR)
Additional Field Studies, Plan Re-evaluation, Response to Comments
60 DAY LEGAL CHALLENGE PERIOD

CDM Camp Dresser & McKee Inc.

Figure 1-5
MEPA Flow Chart
Source: Jason M. Cortell and Assoc. Inc.

One of the types of projects eligible for special review under this provision of MEPA is a project that may affect a large area or several sites. In this case, a special process can be designed and followed as an "area-wide review."

The Phase 1 Muddy River Flood Control, Water Quality, Habitat Enhancement and Historic Preservation Project has been granted an area-wide special review process which contains three procedural elements, which are listed below. Figure 1-6 demonstrates the unique review process under MEPA for this project.

- A Draft and Final EIR for covering the entirety of the project;
- An opportunity for the Charlesgate portion of the project to proceed following the MEPA review and certification of the Draft EIR; and
- Filing and public review of updates on the project progress annually after the Final EIR review is completed.

In addition, the special review process included the designation of a Citizens Advisory Committee (CAC) by the Secretary of Environmental Affairs.

1.3.2 Establishment of the Citizen's Advisory Committee

At the request of the project proponents in the ENF, a CAC has been established to assist the Secretary in the environmental review of this project. Supported by project proponents administratively, the CAC met regularly (i.e., thirty-one times between September 1999 and November 2001) with the proponents and their consultants to provide input on all aspects of the project. The CAC also held meetings to inform the public on the project status. An early draft of the DEIR was provided to the CAC for a 120-day (April 23 to August 17, 2001), opportunity to comment and their comments are included in this DEIR at Appendix K . A list of the CAC members is found in Section 3, which also includes a description of all CAC meetings held to date.

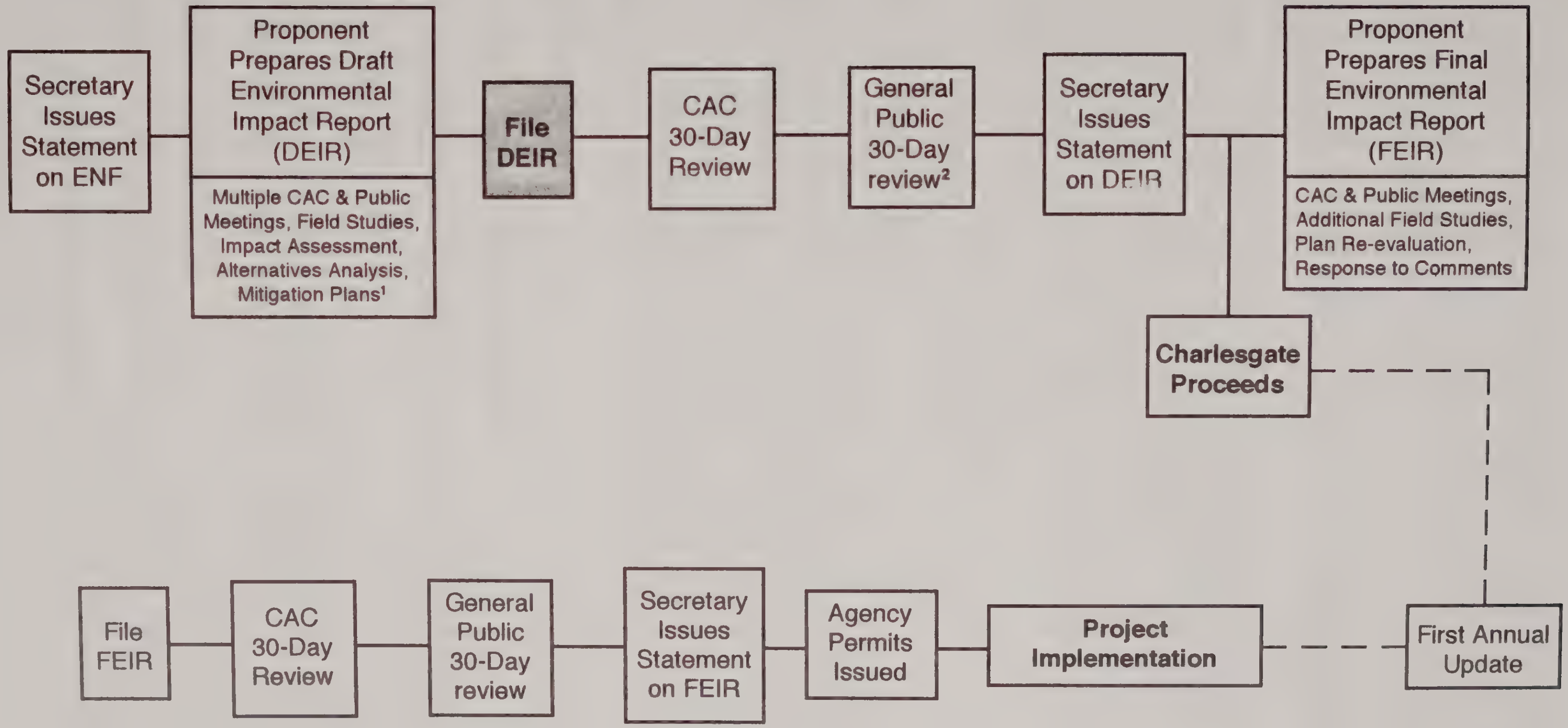
1.3.3 Annual Update

The special review procedure for the Muddy River Project mandates that the MEPA office and project commenters be updated annually following the completion of the Final EIR. Of interest are the status of physical improvements, management practices, and information regarding current environmental conditions gathered through monitoring, The Annual Updates also will provide the necessary documentation regarding later phases of the project whose impacts are not evaluated in detail in this DEIR.

The first Annual Update is anticipated to be filed one year after construction commences, probably during the last quarter in 2002.

As required by the Secretary of Environmental Affairs, a proposed outline reflecting a scope of work for the Annual Updates for the project has been prepared (see Section 9 of this DEIR). The concept of continuity drives this outline, as does a need for flexibility

SPECIAL REVIEW PROCEDURES FOR ENVIRONMENTAL IMPACT REVIEW OF THE MUDDY RIVER PROJECT


Secretary Issues Statement on ENF
Proponent Prepares Draft Environmental Impact Report (DEIR)
Multiple CAC & Public Meetings, Field Studies, Impact Assessment, Alternatives Analysis, Mitigation Plans¹
File DEIR
CAC 30-Day Review
General Public 30-Day review²
Secretary Issues Statement on DEIR
Proponent Prepares Final Environmental Impact Report (FEIR)
CAC & Public Meetings, Additional Field Studies, Plan Re-evaluation, Response to Comments
Charlesgate Proceeds
File FEIR
CAC 30-Day Review
General Public 30-Day review
Secretary Issues Statement on FEIR
Agency Permits Issued
Project Implementation
First Annual Update

[1] Will include a 60-day period where CAC comments on pre-filing DEIR and comments incorporated for filing DEIR.

[2] Potentially extended to 60-days, if requested as expected.

Figure 1-6
Special Review Procedures
Source: Jason M. Cortell and Assoc. Inc.

with respect to the sequencing of future project phases. Each report will build upon the report that proceeds it, providing an update with respect to interim progress in implementation of funded project elements and on success with regard to funding of future project elements. The Annual Update will be circulated to all parties who commented on either the ENF or EIR.

1.4 State and Local MOU for Funding and Administering the Project

In November 1999, a Memorandum of Understanding (MOU) amongst local and state agencies involved in the project was executed. Its purpose is to facilitate cooperation amongst the respective authorities in project planning, permitting, funding, and implementation. The MOU allows for the transfer of funds between participating parties and provides commitments for adherence to all applicable regulatory or programmatic requirements. It also summarizes financial commitments for Phase 1 of the project from participants.

A copy of the MOU is provided in Appendix K.

1.5 Project Permitting

The Muddy River Project will require a number of local, state, and federal permits or approvals. Some required approvals entail multi-jurisdictional potential actions involving local and state (i.e., WPA) state and federal (e.g., 404(b)(1)/Section 401 Water Quality Certification) or local and federal (e.g., Section 106 Review) agencies. This section of the DEIR presents a list of required permits and a brief discussion of requirements that are considered key to the planning and permitting of the Muddy River Project. Additional detail is provided in Section 9.

Local permits include:

- Approvals under the Wetlands Protection Act:
  - Abbreviated Notices of Resource Area Delineation (ANRAD), and
  - Orders of Conditions;
- Approval from the local historic preservation agencies (Boston Landmarks Commission and Brookline Preservation Commission)

State approvals include:

- EIR Approval under the MA Environmental Policy Act,
- The potential for a Superceding Order of Conditions under the WPA Regulations (310 CMR 10.00),

- Determination of No Adverse Impact to Historic Resources by the Massachusetts Historic Commission,
- Approval under Chapter 91, Waterways Regulations (314 CMR 9.00), and
- Section 401 water Quality Certification.

Federal approvals include:

- Environmental impact review under the National Environmental Policy Act (NEPA),
- Compliance with the Clean Water Act (Section 404(b)(1)),
- Section 106 Review pursuant to the National Historic Preservation Act, and
- National Pollutant Discharge Elimination System (NPDES) discharge permit.

Some approvals are considered to be more critical than others, either because of the extent of documentation required or because of the historical importance of the area. They are discussed briefly below.

1.5.1 Massachusetts Wetlands Protection Act

Aspects of the project involving work within or adjacent to certain wetland resource areas must be approved under provisions of the Massachusetts Wetlands Protection Act (WPA). It is assumed that work potentially affecting these resources areas will be approved primarily under 310 CMR 10.53(4), which states that the issuing authority (Boston or Brookline Conservation Commissions or the Department of Environmental Protection) may:

> *"… issue an Order of Conditions for the projects which will improve the natural capacity of a resource area(s) to protect the interests identified in M.G.L. c 131… Such projects include, but are not limited to, the removal of aquatic nuisance vegetation to retard pond and lake eutrophication and the thinning or planting of vegetation to improve habitat value."*

The regulation also states that no project:

> *"… may be permitted which will have any adverse effect on specified wildlife habitat sites of rare vertebrate or invertebrate species as identified by procedures established under 310 CMR 10.59".*

Sections 6 and 9 of this DEIR demonstrate the applicability of these regulatory provisions to the Muddy River Project.

1.5.2 Standards and Criteria for Evaluating Cultural and Historic Resources

Definitions

The Muddy River restoration will occur in the setting of an historic designed park, which is listed on the National Register of Historic Places and is a local landmark and a cultural landscape. Any work in the park must take into consideration the regulatory requirements for historic designed landscapes and cultural landscapes including Section 106 review and review by the Massachusetts Historical Commission (MHC) under the General Laws of the Commonwealth.

The following definitions clarify these terms:

In 1971 The Emerald Necklace Parks were places on the National Register and in 1983 they were designated a Landmark by the City of Boston.

- **Historic Property (Park)** - is defined as a district, site, structure or landscape significant in American history, architecture, engineering, archeology, or culture. It is also an umbrella term for all entries in the National Register of Historic Places.
- **Cultural Landscape** - is defined as a geographic area, including both cultural and natural resources and the wildlife or domestic animals therein associated with a historic event, activity, or person, or that exhibits other cultural or aesthetic values. The four general kinds of cultural landscapes are ethnographic, historic designed, historic vernacular, and historic site. The Emerald Necklace Parks are a designed landscape.
- **National Historic Landmark** - is defined as a district, site, building, structure, or object of national significance, designated by the Secretary of the Interior under authority of the Historic Sites Act of 1935 and entered in the National Register of Historic Places.
- **National Resister of Historic Places** - is a comprehensive list of districts, sites, buildings, structures and objects of national, regional, state and local significance in American History, architecture, archeology, engineering, and culture kept by the National Park Service under authority of the National Historic Preservation Act (NHPA) of 1966.

The National Register Criteria recognize different categories of significance:

- Criteria A	Properties significant for their association or linkage to events important in the past.
- Criteria B	Properties significant for their association or linkage to persons important in the past.

- Criteria C	Properties significant as representatives of the manmade expression of culture or technology.
- Criteria D	Properties significant for their ability to yield important information about prehistory and history.
- Criteria E	Properties significant as reconstruction accurately executed in a suitable environment and presented in a dignified manner as part of a restoration master plan and when no other building or structure with the same associates has survived.
- Criteria F	Properties significant as a commemorative property designed or constructed after the occurrence of an important historic event or after the life of an important person.
- Criteria G	Properties significant for having achieved significance within the last fifty years, if they are of exceptional importance.

- **Boston Landmark** - To be designated a Landmark the site must meet four criteria as defined in Section 4 of Chapter 772 of the City of Boston Acts of 1975, as amended. The four criteria are:
  - Inclusion in the National Register of Historic Places as provided in the National Historic Preservation Act of 1966;
  - Structures, sites, objects, man-made or natural, at which events have occurred that have made an outstanding contribution to, and are identified prominently with, or which best represent some important aspect of the cultural, political, economic, military or social history of the City, the Commonwealth, the New England region or the Nation;
  - Structures, sites, objects, man-made or natural, associated significantly with the lives of outstanding historic personages;
  - Structures, sites, objects, man-made or natural, representative of elements of architectural or landscape design or craftsmanship, which embody distinctive characteristics of a type inherently valuable for study of a period, style or method of construction or development, or a notable work of an architect, landscape architect, designer or builder whose work influenced the development of the City, the Commonwealth, the New England region or the Nation.
- **Federal Section 106 Review** - Section 106 review was established by the National Historic Preservation Act (NHPA) of 1966 and was strengthened and expanded by the U.S. Code of Federal Regulation 36 CFR Part 800 "Protection of Historic Properties" revised and reissued on September 2, 1986 (51 FR 31115). NHPA requires that every federal agency "take into account" how each of its undertakings could affect historic properties, which can include construction, rehabilitation and repair projects,

demolition, licenses, permits, loans, loan guarantees, grants, Federal property transfers, and many other types of Federal involvement. For purposes of Section 106, any property listed in or eligible for the National Register of Historic Places is considered historic.

The Boston Landmarks Commission and Brookline Preservation Commission would participate as the "certified local government" partner with the Massachusetts Historical Commission in these reviews.

- **Massachusetts Historical Commission (MHC)** - The Massachusetts Historical Commission's authority with respect to historical properties is defined by the Massachusetts General Laws under M.G.L C.9 ss.26-27C, December 1989.

The Emerald Necklace Parks were placed on the National Register of Historic Places in 1971 under Criteria B: Person. In 1978, Commonwealth Avenue Mall, including Charlesgate, was designated a landmark by the City of Boston and in 1983, the Emerald Necklace Parks were designated a landmark by the City of Boston.

1.5.3 Army Corps of Engineers/Federal Emergency Management Agency Environmental Assessment

The City of Boston and Town of Brookline have sought Federal Emergency Management Agency (FEMA) funding to remove several feet of accumulated debris and sediment from the Charlesgate portion of the Muddy River, i.e., the section between Ipswich Street and the Muddy River outfall at the Charles River. This debris and sediment was determined to be an aggravating factor in the severe extent of flood damage incurred at adjacent homes, businesses, and public infrastructure as a result of flooding caused by heavy rainfall that occurred on October 20 and 21, 1996. Flood damage was of sufficient magnitude to warrant a Presidential disaster declaration.

FEMA's Hazard Mitigation Grant Program (HMGP), the funding source, assists communities by providing funds for projects that implement mitigation measures to protect life and property from effects of natural disaster. Funding for mitigation projects was made available to the city after the Presidential declared disaster in October 1996, in order to prevent damages from future flood events. An Environmental Assessment (EA) was prepared, as required for FEMA to fund the Charlesgate Hydraulic Improvement Project. FEMA issued a Finding of No Significant Impact (FONSI) based on the EA. Appendix K contains a copy of the FEMA FONSI.

In addition to FEMA's role with respect to flood mitigation at Charlesgate, assistance also is being sought from the Army Corps of Engineers (ACOE) for flood mitigation upstream of Charlesgate. The ACOE has commenced analysis of the entire project required under NEPA preliminary to its preparation of an EA. .

1.5.3.1 Purpose and Need

The purpose and need for the Charlesgate activities primarily was to reduce the potential for flooding and the flood impacts to the built environment in the vicinity of the Muddy River.

1.6 Summary of Previous Engineering and Environmental Studies

The Muddy River has received much attention in recent history. Well before the flooding that occurred in 1996, water quality studies had been underway since 1974. Previous studies on the Muddy River are summarized as follows:

1.6.1 Flood Control

Flood control studies have been published by the Federal Emergency Management Agency, the Executive Office of Environmental Affairs, and the US Army Corps of Engineers. Each of the studies have identified the poor hydraulic conditions that exist in the Charlesgate Area, the Back Bay Fens and the culverted sections as the principal reasons for the flooding. They have resulted in the recommendation that sediments be removed form these areas and that the culverted sections either be daylighted and/or enlarged.

1.6.2 Sediment Quality

The quality of sediment in the Muddy River has been documented by the ACOE (1992, 2000) and the US Geological Survey (1997-1998). Each of these studies resulted in the finding that the sediment is highly contaminated with petroleum hydrocarbons, toxic metals, and chlorinated compounds.

1.6.3 Water Quality

Water quality in the Muddy River has received considerable attention. The studies that have been conducted include:

▪ Division of Water Pollution Control (now the MA DEP)	1974
▪ Division of Water Pollution Control (now the MA DEP)	1981
▪ Division of Water Pollution Control (now the MA DEP)	1986
▪ Army Corps of Engineers	1992
▪ Northeastern University	1995
▪ Charles River Watershed Association (CRWA)	1998

The US Geological Survey has operated a station for flow and water quality monitoring (MA01104683) at the Netherlands Road bridge since 1999 but has not reported data since September 1999 due to budget constraints.

Data from the other reports is scattered and lacks consistency in monitoring river conditions. In very general terms the quality was worse in these reports than the current monitoring presented in this report.

1.6.4 Wildlife

Wildlife resources were documented by Dr. Gwinlym Jones of Northeastern University and the ACOE (1992). Documentation included vegetation (aquatic and riparian), fish, bird, mammals, reptiles, and amphibians.

1.7 Project Objectives

In order for the Phase I Muddy River Flood Control, Water Quality and Habitat Enhancement, and Historic Preservation Project to provide as much environmental enhancement as possible, a series of Project Objectives and a set of alternative actions to implement each Project Objective were developed. The Project Objectives are:

- Provide Flood Control;
- Improve Water Quality;
- Enhance the Aquatic and Riparian Habitat;
- Restore Landscape and Historic Resources; and
- Institute Best Management Practices in the Muddy River Watershed.

The Project Objectives and alternatives for each objective were reviewed with the Citizens Advisory Committee (CAC). Based on the CAC's comments, engineering plans were developed. The Project Objectives and alternative actions are presented in the following sections and the alternatives for each objective are discussed in greater detail in Section 2.0.

It is to be noted that because the Muddy River Project is intended to result in the overall enhancement of the Emerald Necklace Parks, that each Project Objective is inter-linked with the implementation and benefits of other Project Objectives.

1.7.1 Provide Flood Control

The October 1996 storm was selected as the design storm because of its intensity and the extensive flood damage that resulted. Appendix E contains the results of hydraulic modeling of this storm. The need for flood control extends throughout the project area, from the Charlesgate, as the downstream most portion, through Leverett Pond. In order to provide flood control, the hydraulic capacity of the Muddy River must be improved. The alternative actions to deal with flooding include:

- Dredging of the Muddy River;
- Daylighting of culverted sections;

- Culvert Enlargement;
- Diversion of Stormwater; and
- Upstream Storage.

Throughout the Muddy River sediment has accumulated from streets, erosion, leaf litter, root mats of *Phragmites*, and debris. There are several locations where street sand has accumulated as sand bars at or above the water surface. The sediment is present along the entirety of the Muddy River including Willow Pond. In the Charlesgate area, there are large sediment accumulations that reduce the flow capacity. There is also a submerged weir at Ipswich Street that must be removed. Throughout the back Bay Fens and Riverway the sediment has accumulated to such an extent that the water depth is less than one foot. Extensive growth of *Phragmites* extends into the flow channel and has severely constricted the open water area. In Leverett Pond, street sand has accumulated to the extent that a large sand bar has re-appeared in front of the Village Brook Drain and the Pond itself has been reduced in depth. Willow Pond is also nearly full of sediment, most of which appears to have been contributed by the Chestnut Street Drain.

Between the Back Bay Fens and The Riverway, the Muddy River passes through two 6-foot diameter culverts. These culverts pass under the former Sears parking lot and the adjacent roadways. There are is also a culverted section at the Fens Bridge. For The Riverway and upstream reaches, the culverts present a severe restriction to the flow of water. Even under dry conditions more than half of the culvert diameters are under water. Therefore, in order to enhance the passage of floodwater, the culverts either should be enlarged and/or removed and the buried sections daylighted.

1.7.2 Improve Water Quality

Since the early development of the watershed, the quality of water in the Muddy River has been degraded from the discharge of sewage through combined sewers and illegal connections between homes and street drains, stormwater, the proliferation of roadways, and the general effects of urbanization. Recent federal, state and municipal efforts have resulted in the elimination of illegal connections, the separation of combined sewers, the implementation of catch basin improvement programs and BMP's, as well as other measures to improve the quality of runoff.

The Phase I Muddy River Project is predicated on the enhancement of the aquatic, wetland and riparian habitat. This includes such alternative actions to improve water quality as:

- Dredging and Removal of Contaminated Sediment;
- Point Source Control;
- Continued Elimination of Illegal Sewer Connections;

- Sewer Separation;
- Flow Augmentation;
- Aeration;
- Harvesting of Aquatic Vegetation; and
- Implementation of Best Management Practices on Stormwater Runoff.

As is discussed in Appendix F - Sediment Quality, the Muddy River sediment is contaminated to varying degrees with nutrients, oxygen-demanding constituents, petroleum hydrocarbon compounds, toxic metals, chlorinated organic compounds including DDT, DDD, and PCBs. One goal of this project is to improve water quality by the improvement of sediment quality and a reduction in the sediment oxygen demand and cycling of nutrients and contaminants between the sediment and water. The Muddy River Project also includes the implementation of a water quality monitoring program (see Section 7.0 - Mitigation) and a Best Management Practices Plan (see Section 8.0) that is focused on the monitoring and improvement of water quality that enters the Muddy River.

Therefore, the benefits that result from dredging the Muddy River begin to increase significantly as they include:

- Improvements to the conveyance and storage of floodwater;
- Improvements to water quality; and
- Improvements to the aquatic and riparian habitat.

The implementation of aeration alternatives, with and without dredging and flow augmentation are other actions that are discussed in Section 2.

1.7.3 Enhance Aquatic and Riparian Habitat

The aquatic and riparian habitat has been degraded as a product of the dramatic increase in the urban use of the surrounding area. This has resulted in poor water quality i.e., low dissolved oxygen, high nutrients, sedimentation, very shallow water, a lack of diverse wetland and shoreline habitat, and over encroachment. To meet the flood control project objective, the dredging will improve sediment quality, as well as water quality. Alternative actions that are intended to further meet the project objective of enhancing the aquatic and riparian habitat are:

- The removal of monotypic species of invasive vegetation;
- The planting of diverse wetland and riparian vegetation;
- The restoration of the historic islands;

- The restoration of flow to the Babbling Brook; and
- Enhancing of fish spawning habitat.

The removal of the monotypic stands of *Phragmites* and other invasive species will enhance flood control, allow the introduction of diverse indigenous species of wetland and shoreline vegetation, and restore and preserve the historic shoreline. An additional benefit of the overall dredging will be the exposure of granular sediments that can be used for the spawning of pan and game fish at locations where it presently does not take place.

1.7.4 Preserve Landscape and Historic Resources

The distinctively designed landscape of the Emerald Necklace Parks has declined due to inattention and the vanishing of many species that were an integral part of the rich and diversified plant palette of Frederick Law Olmsted, his firm, and such twentieth-century successors as Arthur Shurtleff. Significant areas have been overtaken by invasive species, including *Phragmites,* Japanese Knotweed, and glossy buckthorn. As a result, the present landscape lacks the richness and subtlety, and the coherent massing of plant materials that characterized the original conception. In order to preserve and restore the historic landscape and historic resources, the following actions are necessary, either individually or in combination:

- Remove invasive vegetation;
- Preserve and restore the historic river bank configuration along the Muddy River, including restoration of the historic islands; and
- Plant vegetation utilizing the Olmsted firm's planting list and drawing additional guidance from published and manuscript documents and from historic photographs. Such extensive planting will recover the intended landscape character of the various segments of the Emerald Necklace from The Back Bay Fens to Wards Pond.

The implementation and accomplishment of these actions will meet this Project Objective and will increase vegetative, structural, and wildlife diversity substantially.

1.7.4.1 Historic Treatment Objective

The Historical Treatment Objective of this project is to restore Olmsted's vision for a system of parks designed for flood control. Olmsted wrote in the Sixth Annual Report for the Board of Commissioners of the Department of Parks for the City of Boston for the year 1880,

"The policy now suggested for Muddy River would look to the preservation of the present channel with certain modifications and improvements adapted to make it permanently attractive and wholesome… and an element of constantly increasing advantage to the neighborhood. The result, would be a chain of pleasant waters, including the four closely adjoining ponds. … all of

natural and in some degree picturesque outline, with banks wooded and easily to be furnished with verdure and foliage throughout."

Charles Beveridge in the 1990 Master Plan for The Emerald Necklace Parks – Jamaica Pond, Olmsted Park, Riverway & Back Bay Fens wrote:

"Early in his career Olmsted sought to have communities preserve the courses of streams for recreational purposes rather than to neglect them and then later bury them in sunken culverts and build over them."

"The water bodies from the Charles to Jamaica Pond are the most extensive and ambitious "passage of scenery" that Olmsted attempted in any of his public parks. These parks contain the most complex system of ways he ever designed, combining major landscape elements with efficiency and amenity. At the same time, the Back Bay Fens and the "Muddy River Sanitary Improvement" (as he called what is now referred to as the Riverway and Olmsted Park) was the most ambitious undertaking in sanitary engineering that Olmsted saw realized in any of the cities in which he worked.

The importance of these parks lies in the marriage of engineering and aesthetics and the consistent vision of Olmsted in developing a system of parks while maintaining each park's own distinct character and identity. The Muddy River Restoration Project will address flood control, stormwater runoff, daylighted storm systems, water quality, and impacts on wetlands, but equally important will be minimizing impacts on the Olmsted landscape, mitigation of impacts and restoration of the park system. This will again require the marriage of engineering and landscape design to preserve and restore the most important of Olmsted's park systems. In order to minimize impact and maintain the integrity and distinct identity of the individual parks within the system, a clear understanding of the design of the park system and thoughtful engineering methodologies will be required.

Under the National Park Service (NPS) Guidelines and Standards, an inventory and analysis of the existing and historical resources of the landscape are completed prior to development of Treatment Plans.

1.7.4.2 Existing Conditions Inventory, Documentation and Analysis

In an effort to gain an understanding of the existing condition of the site and the context in which the Muddy River is situated, a comprehensive inventory, documentation, and analysis of the landscape has been completed. This effort establishes the current condition of the landscape, both physically and ecologically. The inventory includes what the National Park Service guidelines describe as character defining features. Under the NPS guidelines these features can include, but are not limited to, the following:

- Spatial Relationships;
- Surroundings;
- Views and Vistas;
- Topography;
- Circulation Systems and Site Entries;
- Vegetation;
- Water Features;
- Furnishings and Objects;
- Microclimates;
- Stormwater, Drainage Issues;
- Utilities; and
- Erosion Issues.

Plan documentation is contained in the Appendix C in the form of annotated Existing Conditions Plans.

1.7.4.3 Historical Research, Documentation and Analysis:

- In an effort to gain the understanding of the historical and cultural context in which the Muddy River is situated, we have completed a comprehensive historical survey of the site. Compilation of historic plans, photographs, drawings, parks reports, etc. has allowed us to study and understand the original designs and design intent of the landscape designers.

- The following archives, collections, and resources were explored:

  National Park Service, Frederick Law Olmsted National Historic Site
  Olmsted Plans and Drawings Collection
  Brookline, MA.

  Library of Congress, Washington, D.C. Olmsted Papers,
  Manuscript Division: Frederick Law Olmsted Papers, Olmsted Association Records,
  And Laura Wood Roper Papers

  Boston Public Library, Rare Book Department
  Boston, MA.

Brookline Public Library
Brookline, MA.

Frances Loeb Library, Graduate School of Design
Harvard University
Cambridge, MA.

City of Boston
Parks Report and Drawing Collection
Boston Parks and Recreation; Department
Boston, MA.

City of Boston Archive
Hyde Park, MA.

Metropolitan District Commission
Drawings Collection
Boston, MA.
Society for the Preservation of New England Antiquities
141 Cambridge Street
Boston, MA.

- The list of historic plans collected, studied, and analyzed is contained in the Appendices.

1.7.5 Institute Best Management Practices for Stormwater Runoff

In addition to the objective of improving water quality, a related objective will be the implementation of a Best Management Practices (BMP) Plan. The objectives of the BMP plan include:

- Minimize re-sedimentation rates
- Contribute to an improvement of water quality to Class B Water Quality Standards
- Maintain project improvements
- Reduce runoff volume
- Contribute to fishing and recreational uses in the Muddy River
- Contribute to fishable/swimmable goal for the Charles River and to contribute to attaining the Class B Water Quality Standards

The BMP Plan is intended to result in the net improvement of water quality. The BMP Plan will consist of non-structural and structural measures. See Section 5 for a detailed description of the BMP Plan.

1.8 Purpose and Organization of the DEIR

This Draft Environmental Impact Report (DEIR) was prepared in response to the Scope issued by the Secretary of Environmental Affairs on April 29, 1999 (see Appendix k). The DEIR describes alternatives in Section 2. Section 3 summarizes the CAC process and public outreach efforts undertaken to date. Section 4 depicts the existing conditions. Section 5 describes the selected alternative. Section 6 contains analyses of impacts. Section 7 identifies needed mitigation and a schedule and commitments for its implementation. Section 8 contains a proposed maintenance and management plan. Section 9 discusses regulatory and statutory requirements, and consistent with the Secretary's guidance, includes a proposed reporting mechanism for advancing the project subsequent to the Final Environmental Impact Report (i.e., the Annual Update). Section 10 outlines a proposed funding strategy. Multiple appendices supplement these sections.

2

Section Two

Section 2
Project Alternatives

This section contains the analysis of alternatives proposed to achieve the project objectives of providing flood control, improving water quality, enhancing aquatic and riparian habitat, Maintaining Cultural and Historic Resources and instituting Best Management Practices. These alternatives were developed based on information from previous studies of the Muddy River, the Secretary's Certificate, and recommendations the Citizens Advisory Committee. The various alternatives were screened to determine whether they fulfilled one or more of the project objectives and engineering plans were developed where appropriate to describe the alternatives.

The discussion and screening of the alternatives is presented at this point in the EIR in order to inform and sensitize the reader to multitude of alternatives that were analyzed in order to meet the requirements of each project objective. As shown in Figure 2-1, the selection of alternatives is an iterative process between environmental impact and cumulative impacts and benefits. In some circumstances, it may be prudent to select a project alternative that may result in a high level of short-term environmental impact but in the ling-term, it results in the greatest environmental benefit.

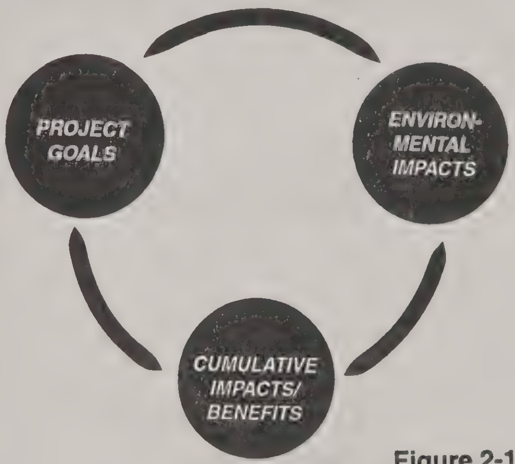


Figure 2-1
Alternative Screening

The alternatives are designed to address the problems that have been identified along the Muddy River as part of the plan to enhance the Emerald Necklace Park system. The most serious problem has been the severe flooding that has occurred in the Muddy River watershed. The October 1996 storm caused significant damage to the MBTA Green Line stations and disrupted activities at several nearby hospitals. Modeling of the river has shown that several culverts and sections of the river have insufficient flow capacity to handle current drainage requirements that result from storms meeting or exceeding the design storm size. The hydraulic capacity of the river needs to be increased in order to provide flood control. Similarly, changes to the Muddy River watershed over time have degraded the water quality and the aquatic and riparian habitat in the park system. The degradation of the river has resulted in a loss of the historical landscape and resources that were part of Olmsted's original design. The alternatives will improve the quality of the river and the surrounding environment.

Table 2-1 contains a summary of the alternatives that were considered for each objective. While an alternative is listed under the primary objective that it was designed to fulfill, many alternatives will partially fulfill more than one of the five project objectives. The following sub-sections describe and screen the various alternatives for each objective, and identify those that fulfill the objective. Additional detail such as engineering design or dredging methods is provided for several of the selected alternatives. A screening of the alternatives is presented at the end of the discussion for each project objective, as well as at the end of this section overall.

Table 2-1

Summary of Phase I DEIR Alternatives

Objective	DEIR Alternative
Flood Control	No Action Infrastructure Alternatives Upstream Storage Floodproofing Dredge Charlesgate Only Dredge Channel through Back Bay Fens Increase Upstream Storage Bank to Bank
Improve Water quality	No Action Eliminate Illegal Sewer Connections Point Source Control Institute BMPs Flow Augmentation Aeration Harvesting of Aquatic Vegetation
Enhanced Aquatic and Riparian Habitat	No Action Improve Water Quality Bank to Bank Dredging Removal of Invasive Vegetation and Planting Wetland Vegetation Restoration/Enhancement of Historic Islands Enhancing Fish Spawning Habitat Restoration of Babbling Brook
Treatment of Cultural and Historic Resources	No Action Source Control Options Treatment Control Options

2.1 Providing Flood Control

The Muddy River has experienced severe flooding over the past several years. During heavy rainstorms on September 17-18 and October 20-21, 1996, and June 13, 1998, drainage in the river overwhelmed the system. The October 1996 storm caused significant damage to the MBTA Kenmore and other Green Line stations, Northeastern University, Wentworth Institute of Technology, the YMCA, the Museum of Fine Arts and other buildings in The Fenway, and a number of primary medical care facilities in the Longwood Medical area.

Flood analysis studies show (see Appendix E) that the flooding is caused by insufficient culvert capacity from The Riverway to Avenue Louis Pasteur and inadequate cross sectional areas of the River downstream of the former Sears parking lot due to sediment accumulation and reed root mass that has grown into the watercourse. In order to relieve upstream flooding, it is necessary to remove these flow constrictions. Surface water modeling of the Muddy River shows that specific improvements to this stretch of the river would reduce the severe flooding during a repeat of the October 1996 storm event. The duration and depth of flooding from storms larger than the October storm also will be reduced. The October 1996 storm is selected as the "design storm" for providing flood control as discussed in Appendix E. The goal of the flood control objective is to increase flow capacity so that the hydraulic grade line does not rise above elevation 15 Boston City Base (BCB) during the design storm in the Riverway. This elevation corresponds to 9.35 NGVD29 (an adjustment of –5.65).

The following alternatives were analyzed to determine whether they would fulfill the project objective of flood control:

- No action
- Infrastructure Improvements-Riverway to Fens Bridge
- Increase Upstream Storage
- Flood-proof Properties
- Dredge Charlesgate Area only
- Dredge Channel through Back Bay Fens
- Bank to Bank Dredging

The alternatives were screened based on the extent of their ability to fulfill the project objective of flood control (fully, partially, and not at all).
The collective goals of these alternatives are:

- To increase flow capacity so that the hydraulic grade line does not rise above elevation 15 Boston City Base.
- To daylight buried portions of the Muddy River.
- To remove flow restrictions and to provide capacity for the design storm through culverts under the roadways.
- To restore as much of the original Olmsted design as practical.

- To remove the contaminated sediments in the upper Fens Pond and to increase the volume of the aquatic habitat.
- To increase the diversity and areal extent of the riparian habitat.
- To stabilize eroding banks.

A detailed discussion of the alternatives' ability to achieve all of the project objectives and the recommended alternatives are included in Section 2.6.

2.1.1 No Action

This alternative would involve not taking any action to remove flow constrictions and leaving conditions along the Muddy River unchanged. The municipal projects that would continue include on-going work by the BWSC on the removal of sediment from the Stony Brook Conduit, and the implementation of the Boston Catch Basin Improvement Project. Brookline and the Boston Parks and Recreational Department would continue it's maintenance of the Emerald Necklace. Brookline would continue complying with it's Consent Agreement with the Environmental Protection Agency (i.e., locating and correcting illegal sewer connections and sewer separation work), its street sweeping and catch basin program would continue, as would its maintenance of the Emerald Necklace park that is within Brookline.

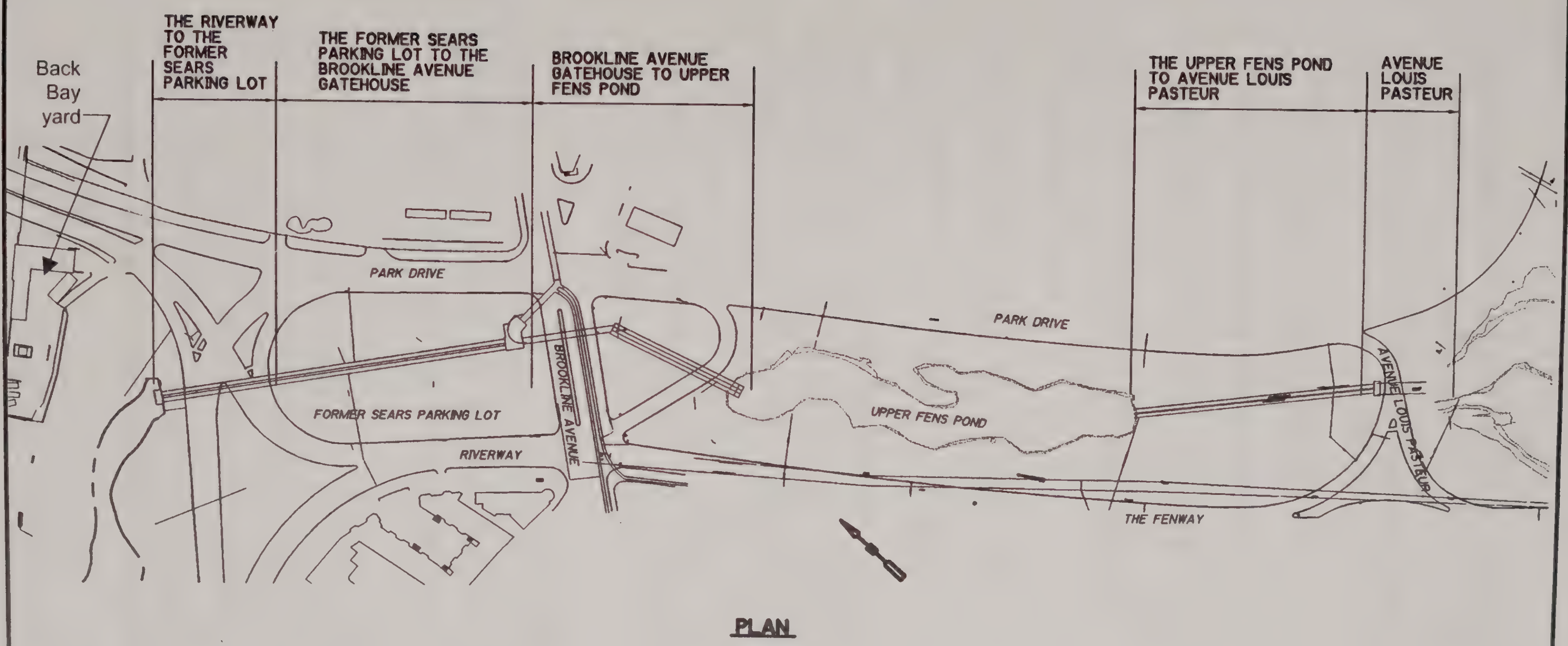
Not taking any action to enlarge the culverts that exist from the Riverway to the Fens Bridge or to increase the channel cross-section in the river would still leave the severe restriction to water flow that has caused flood damage upstream of the former Sears parking lot. Under this alternative, flooding would continue locally around the Back Bay Yard (See Figure 2-2 for location of the Back Bay Yard) and upstream in Brookline. Based on the surface water modeling of the river at the design storm, the hydraulic grade line in the Riverway would rise approximately elevation 19 BCB, which would flood some of the surrounding area.

Continuing the anticipated municipal projects would have little to no affect on the flood levels except for the work at the Stony Brook Conduit. Work on the Stony Brook Conduit could increase flows to the Muddy River that would make the current flooding situation worse downstream of the Stony Brook Conduit due to higher Muddy River levels. This condition was not explicitly modeled, however these affects are expected to be only marginally worse than the current conditions.

The No Action Alternative would not fulfill the flood control objective and would not be retained for further evaluation or consideration.

2.1.2 Infrastructure Improvements – Riverway to Fens Bridge

Modeling of the Muddy River indicated that culverts just downstream of the Riverway (at the former Sears parking lot) have inadequate cross-sectional area for the flow from the design storm. This alternative would remove flow constrictions in


Back Bay yard
THE RIVERWAY TO THE FORMER SEARS PARKING LOT
THE FORMER SEARS PARKING LOT TO THE BROOKLINE AVENUE GATEHOUSE
BROOKLINE AVENUE GATEHOUSE TO UPPER FENS POND
THE UPPER FENS POND TO AVENUE LOUIS PASTEUR
AVENUE LOUIS PASTEUR
PARK DRIVE
FORMER SEARS PARKING LOT
RIVERWAY
BROOKLINE AVENUE
PARK DRIVE
UPPER FENS POND
THE FENWAY
AVENUE LOUIS PASTEUR
PLAN

Not to Scale

Figure 2-2
Areas of Proposed Improvements
Riverway to Avenue Louis Pasteur

CDM Camp Dresser & McKee Inc.

culverts located between the Riverway and Fens Bridge, which, in turn, would lower the hydraulic grade line of the river.

In order to lower the hydraulic grade line in The Riverway to Avenue Louis Pasteur area, five areas will need improvements:

- The Riverway to the former Sears parking lot;
- The former Sears parking lot to the Brookline Avenue Gatehouse;
- The Brookline Avenue Gatehouse to Upper Fens Pond;
- The Upper Fens Pond to Avenue Louis Pasteur; and
- Avenue Louis Pasteur.

The location of these areas is shown on Figure 2-2.

2.1.2.1 Infrastructure Improvements - Daylighting Culverted Sections of the Muddy River

The terminology "daylighting" means opening the closed or covered portions of the channel and restoring a natural open channel. Daylighting sections of the channel increases hydraulic capacity by increasing the cross sectional area of flow and by providing additional storage capacity when needed. Since the water surface elevation is not restricted by a culvert, it can rise in the open channel during high flow periods. The varying surface elevation makes us of additional storage capacity within the daylighted channel. Daylighting can only be used in areas where the water surface can be exposed; it cannot be used where there are structures such as roads or buildings over the channel.

The two areas proposed for daylighting or open channeling are the former Sears parking lot and upstream of Avenue Louis Pasteur. The alternatives for daylighting are engineered channels, natural channels with historical alignment, and natural channels with modified historical alignments. Each of the alternatives includes a 4-foot wide shelf for wetland replication on each side of the channel. This is discussed in more detail in Section 5.

When the Muddy River originally was designed by Frederick Law Olmsted, the former Sears parking lot and upstream of Avenue Louis Pasteur were open channels. As the surrounding land was developed, twin 72-inch pipelines were laid at the bottom of the channels and were covered to create space for a parking lot and a grassed park. A large concrete drainage structure at the entrance to the culverts under the former Sears parking lot was built with bar racks on three sides and a grate over the top to trap debris and still allow water into the pipelines. The twin 72-inch diameter concrete pipelines under the former Sears parking lot are each 520-feet long.

Upstream of Avenue Louis Pasteur there are also twin 72-inch diameter concrete pipelines, each approximately 355 feet long. The inlet end is not visible from the surface, but construction drawings show the pipes are set at an elevation lower than the Muddy River downstream. The drains are buried and connect to the culvert at Avenue Louis Pasteur. A large cast-in-place concrete structure was built around this connection.

Drains in both locations are undersized and cannot handle the large runoff volumes during heavy storm events, which results in a "bottleneck" effect. Opening these through daylighting will relieve the system.

Engineered Channel

The Army Corp of Engineers' June 2000 Draft Evaluation Report Phase I Muddy River Master Plan proposed the construction of engineered channels in the daylighting area. An engineered channel could be either concrete or riprap lined with the shortest alignment possible, usually a straight line. This option is generally less costly, and provides a simple hydraulic design. However, this configuration does not restore the historic shoreline alignment, does not recreate the island upstream of Avenue Louis Pasteur, would not provide aquatic habitat, and would not be more compatible with the historic surroundings.

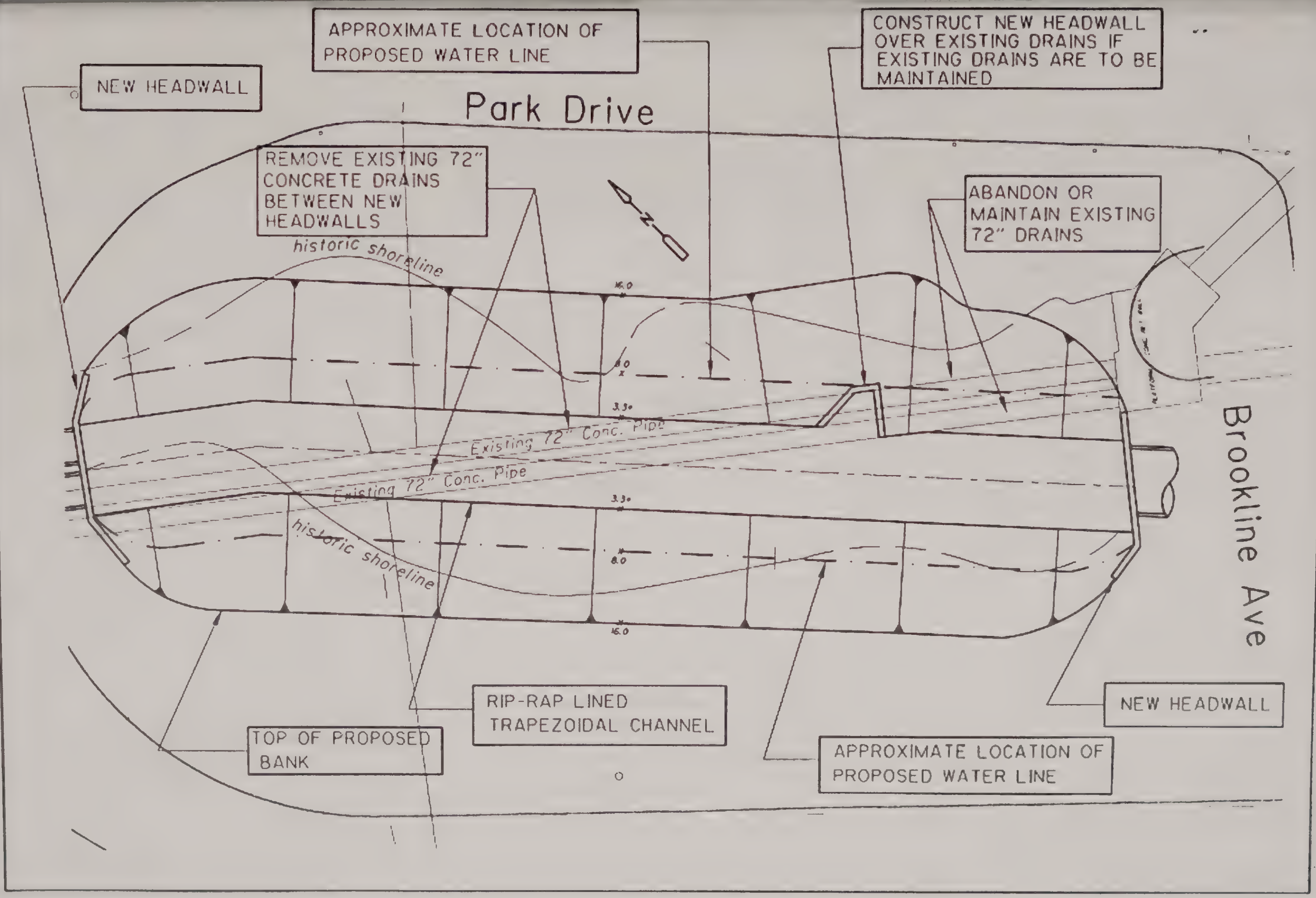
The engineered straight channel alternative at the former Sears parking lot includes the removal of the existing 72-inch drains as shown on Figure 2-3. The shoreline configuration from historical records is also shown on Figure 2-3 along with the shoreline for the engineered channel. Flow also needs to be maintained to the Brookline Avenue Gatehouse.

Upstream of Avenue Louis Pasteur engineered channel improvements include the removal of the existing 72-inch drains as shown on Figure 2-4.

Natural Replacement – Historic Alignment

Another alternative for daylighting at the former Sears parking lot and upstream of Avenue Louis Pasteur is to construct a natural looking channel that matches the historical alignment. The channel would be trapezoidal in shape, and the shoreline would match the historic shoreline closely. The bottom and sides of the channel would be lined with gravel and a layer of riprap up to the water line. From the water line up to the top of the bank, an erosion control mat would be used to prevent soil failure on the side slopes and erosion of vegetation due to the water line fluctuation.

The former Sears parking lot improvements considered include the removal of the existing 72 inch drains and the construction of a riprap lined trapezoidal channel that matches the historic alignment closely as shown on Figure 2-5. This alternative restores a portion of the original Olmsted alignment. However, this design is more costly than the engineered channel and the alignment would not match up with the recommended culvert improvements in The Riverway upstream, which is described in Section 2.1.2.2.


APPROXIMATE LOCATION OF PROPOSED WATER LINE
CONSTRUCT NEW HEADWALL OVER EXISTING DRAINS IF EXISTING DRAINS ARE TO BE MAINTAINED
NEW HEADWALL
Park Drive
REMOVE EXISTING 72" CONCRETE DRAINS BETWEEN NEW HEADWALLS
ABANDON OR MAINTAIN EXISTING 72" DRAINS
historic shoreline
16.0
8.0
3.3
Existing 72" Conc. Pipe
Existing 72" Conc. Pipe
3.3
historic shoreline
8.0
16.0
Brookline Ave
RIP-RAP LINED TRAPEZOIDAL CHANNEL
TOP OF PROPOSED BANK
NEW HEADWALL
APPROXIMATE LOCATION OF PROPOSED WATER LINE

Not to Scale

Figure 2-3
Former Sears Parking Lot Proposed Improvements
ACOE-Straight Channel

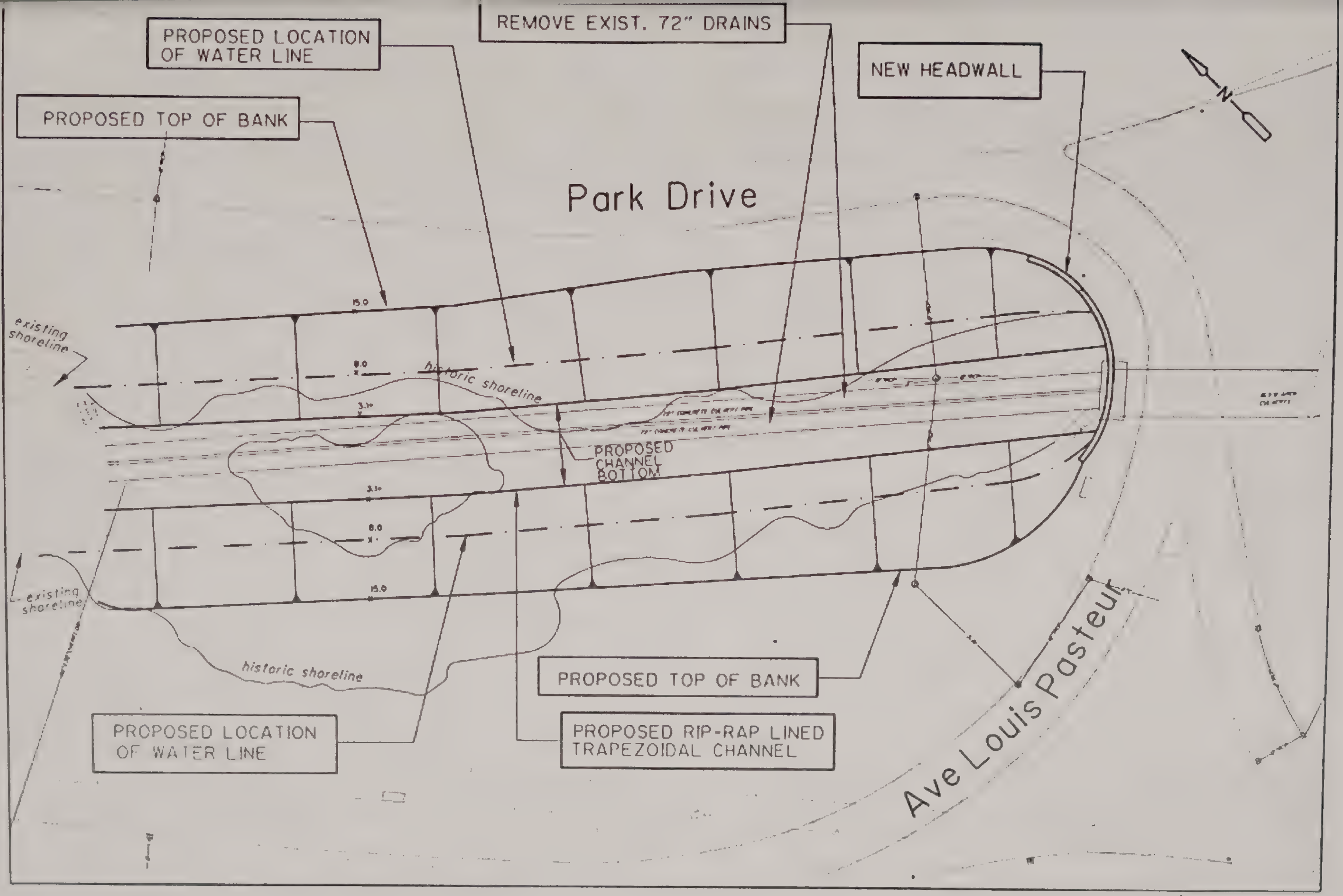


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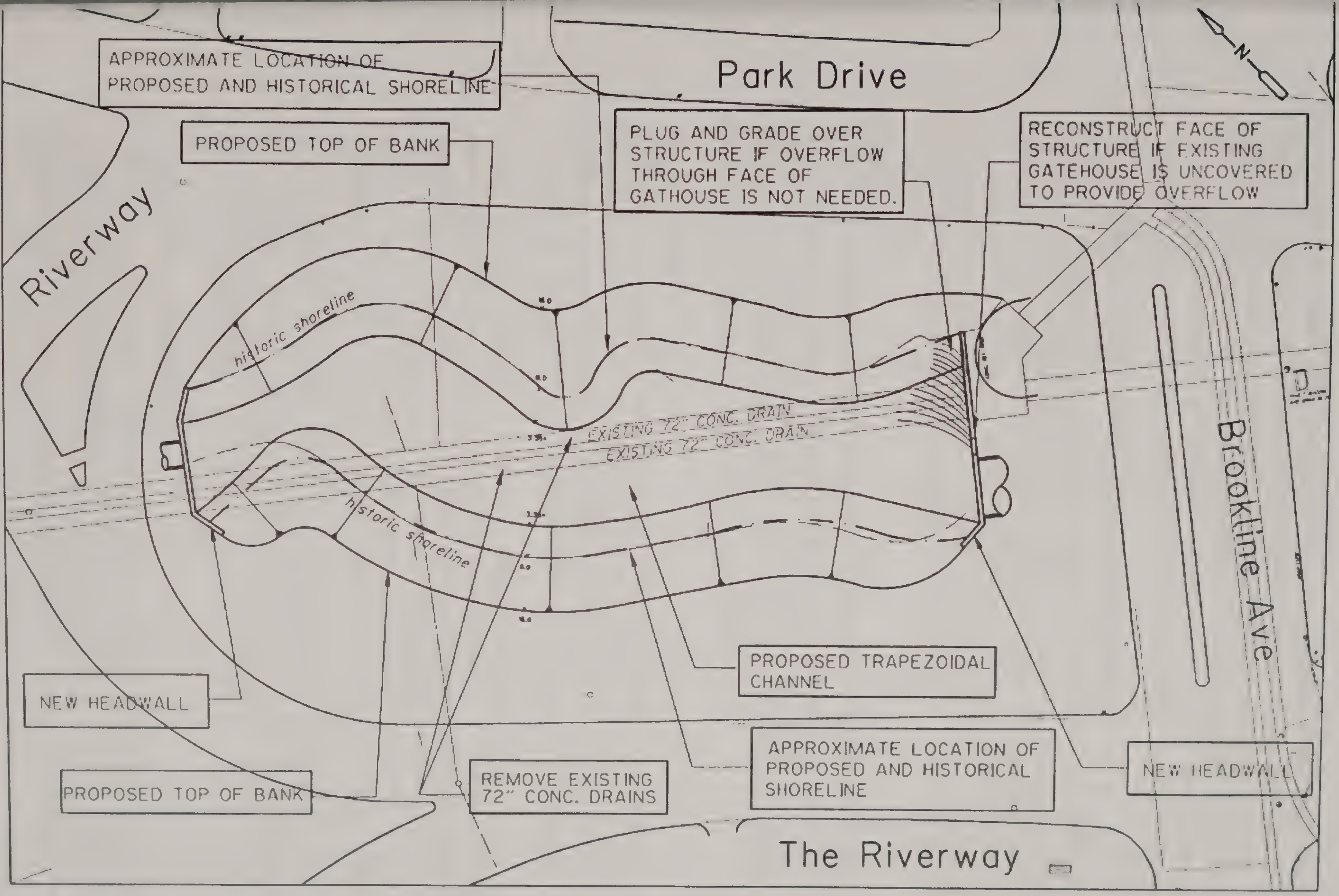
Figure 2-4
Upstream of Avenue Louis Pasteur Proposed Improvements
ACOE-Straight Channel


APPROXIMATE LOCATION OF PROPOSED AND HISTORICAL SHORELINE
Park Drive
N
PROPOSED TOP OF BANK
PLUG AND GRADE OVER STRUCTURE IF OVERFLOW THROUGH FACE OF GATHOUSE IS NOT NEEDED.
RECONSTRUCT FACE OF STRUCTURE IF EXISTING GATEHOUSE IS UNCOVERED TO PROVIDE OVERFLOW
Riverway
historic shoreline
EXISTING 72" CONC. DRAIN
EXISTING 72" CONC. DRAIN
historic shoreline
Brookline Ave
PROPOSED TRAPEZOIDAL CHANNEL
NEW HEADWALL
APPROXIMATE LOCATION OF PROPOSED AND HISTORICAL SHORELINE
NEW HEADWALL
PROPOSED TOP OF BANK
REMOVE EXISTING 72" CONC. DRAINS
The Riverway

Not to Scale

Figure 2-5
Former Sears Parking Lot Proposed Improvements
Channel Closely Matches Historic

Upstream of Avenue Louis Pasteur the historic alignment alternative includes the removal of the existing 72 inch drains and the construction of a riprap lined trapezoidal channel that matches the historic alignment as shown on Figure 2-6. As part of the improvements, a small island from Olmsted's original channel design would be constructed. This alternative is more expensive than the engineered channel. However, it would restore the Muddy River to its historical alignment.

Natural Replacement - Modified Historical Alignment

The third alternative for daylighting applies only to the former Sears parking lot and also includes the construction of a natural looking channel. The alternative modifies the historic alignment providing more room for walkways at Park Drive and lines up the new channel with the recommended culvert alignment at The Riverway as shown on Figure 2-7. Removal of the 72-inch drains and details of the trapezoidal section are similar to the historic alignment alternative and the cost is comparable to the previous alternative.

2.1.2.2 Infrastructure Improvements-Enhancement of Culvert Capacity

The sections proposed for culvert replacement/capacity enhancement are The Riverway, Brookline Avenue, and Avenue Louis Pasteur (Fens Bridge). The proposed work either would replace or enlarge the existing culverts by jacking, or by cut and covering new, larger culverts to increase flow capacity.

Jacked Culvert

This option considered installing new or additional culverts by jacking methods. Jacking a culvert consists of excavating a pit (jacking pit), on either side of the roadway and then hydraulically pushing pipe segments under the roadway to the opposite pit. Soil is removed from the pipeline as it is jacked under the roadway.

Jacking is advantageous because it does not require the excavation that cut and cover methods require, and reducing excavation in roadways would minimize traffic disruption during construction. To jack culvert structures, the underlying soils must be able to support the weight of the culverts since foundations such as piles cannot be installed underneath the culvert. Soil borings were taken and tests were performed to determine foundation requirements for proposed culverts. The results indicate that the soil does not have the bearing capacity to support the weight of the new culverts without special foundations such as woodpiles and caps (Further discussion on foundations is found in Appendix I). Based on the foundation requirements, jacking new culverts under the roadways is technically infeasible; therefore this alternative was not considered further.

Cut and Cover Construction

Cut and cover construction involves excavating an open trench, installing foundations and culverts and then backfilling over the culverts. In sections of the project where construction would be cross roadways, traffic flow would be maintained by performing cut and cover in multiple phases. Rather than open cutting across the

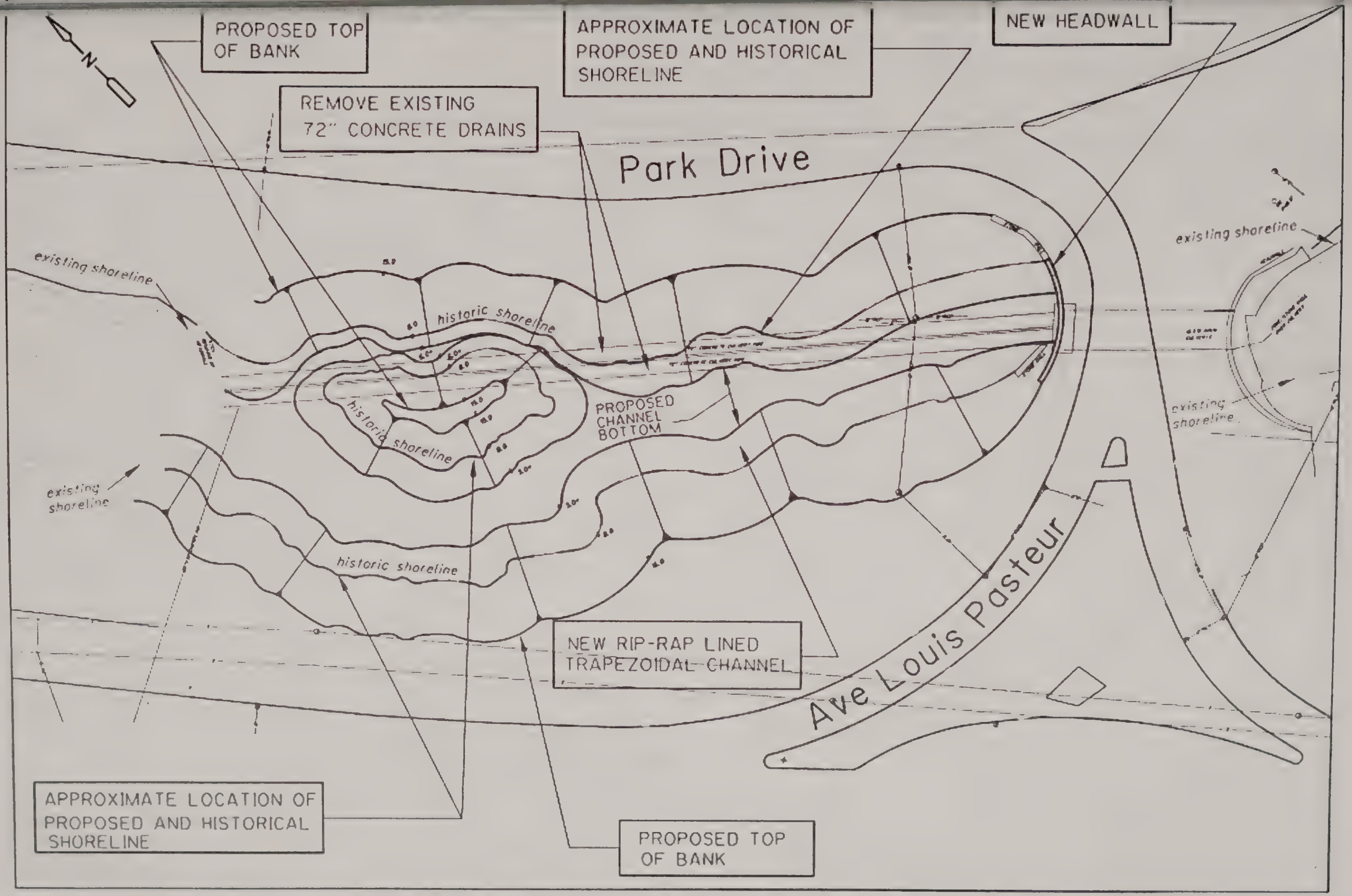


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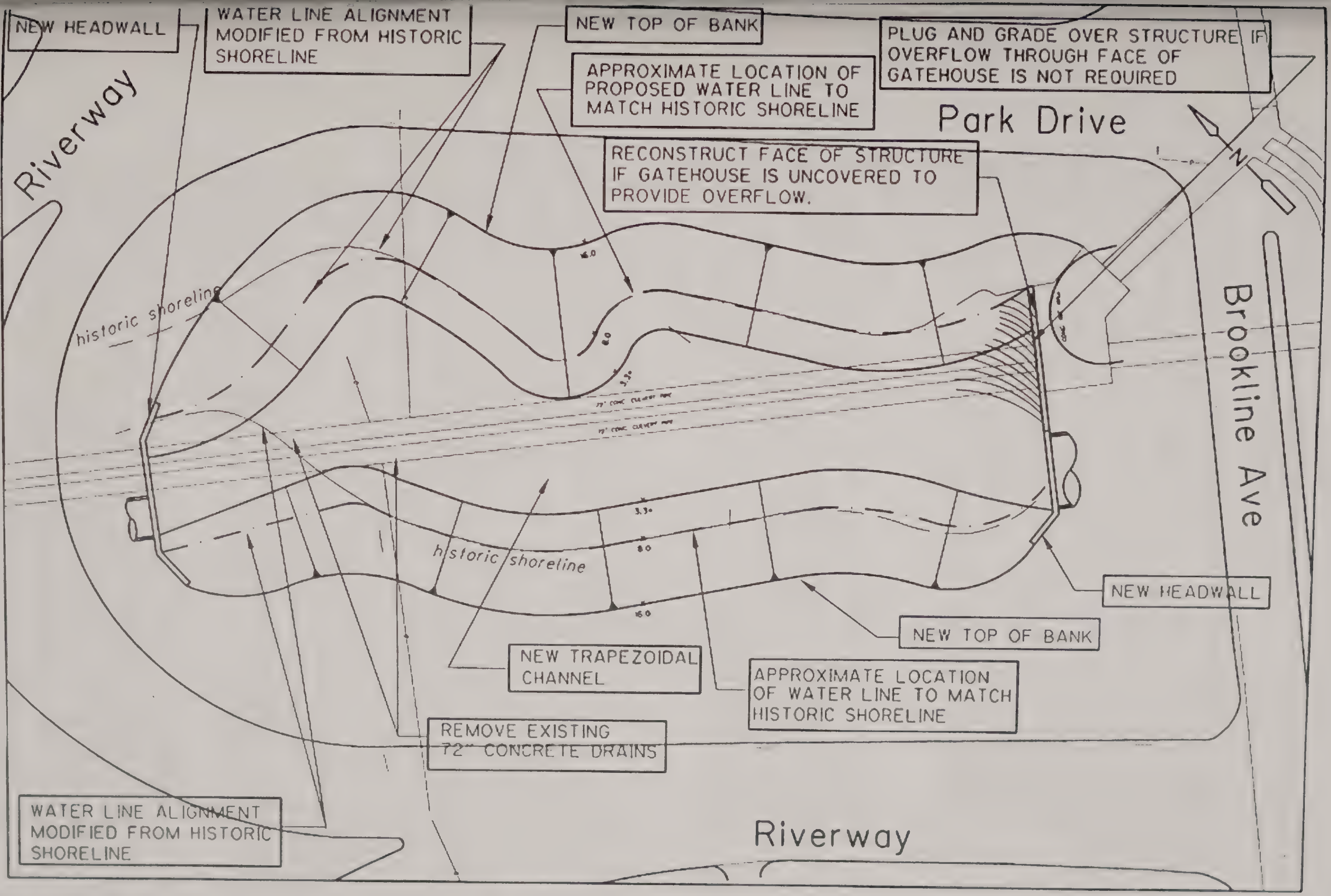
Figure 2-6
Upstream of Avenue Louis Pasteur Proposed Improvements
Channel Matches Historic


NEW HEADWALL
WATER LINE ALIGNMENT MODIFIED FROM HISTORIC SHORELINE
NEW TOP OF BANK
APPROXIMATE LOCATION OF PROPOSED WATER LINE TO MATCH HISTORIC SHORELINE
PLUG AND GRADE OVER STRUCTURE IF OVERFLOW THROUGH FACE OF GATEHOUSE IS NOT REQUIRED
Park Drive
N
RECONSTRUCT FACE OF STRUCTURE IF GATEHOUSE IS UNCOVERED TO PROVIDE OVERFLOW.
Riverway
historic shoreline
16.0
8.0
3.3
72" CONC CULVERT PIPE
72" CONC CULVERT PIPE
Brookline Ave
historic shoreline
3.3
8.0
16.0
NEW HEADWALL
NEW TOP OF BANK
NEW TRAPEZOIDAL CHANNEL
APPROXIMATE LOCATION OF WATER LINE TO MATCH HISTORIC SHORELINE
REMOVE EXISTING 72" CONCRETE DRAINS
WATER LINE ALIGNMENT MODIFIED FROM HISTORIC SHORELINE
Riverway

Not to Scale

Figure 2-7
Former Sears Parking Lot Proposed Improvements
Channel with Modified Historical Alignment

entire roadway, construction would be sequenced. As one side is completed, traffic would be shifted to construct the other side.

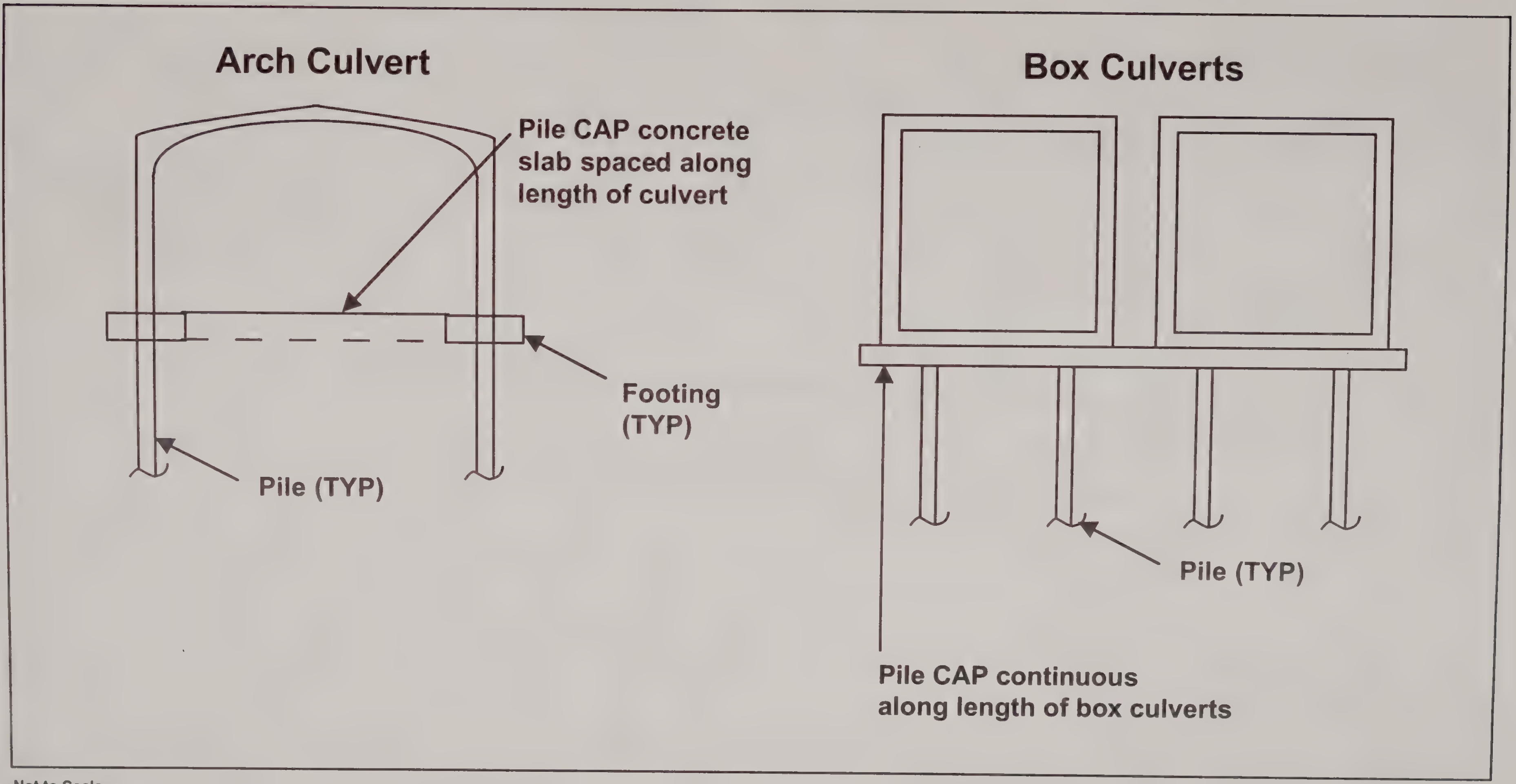
The new culverts can be either box culverts or arch culverts (See Figure 2-8). Due to the low soil bearing capacity, new culverts would require piles. A box culvert would require a continuous cast-in-place pile cap over evenly spaced piles under the box. Piles for the arched culvert can be placed in two lines with cast in place pile caps. As a practical matter the width of box culverts is about 10 to 15 feet. The arch culvert can span in excess of 20 feet. The foundation conditions for box culverts are more complex for double culverts, however the arches are somewhat more labor intensive to place. The end result is that costs are similar. The difference however, is that the arch culvert and headwall with the arch shape are more in keeping with the shape of historic structures designed by Olmsted and are proposed for culvert replacement or enlargement.

The Riverway

The existing pipelines under The Riverway will be replaced or enlarged with new culverts about 200 feet long. Since maintenance access is provided at each of the shortened culvert, blockage is much less likely to occur and more easily removed. Therefore the screen rack structure at the inlet side of the drains will be removed. The structure as described under Section 2.1.2.1 was meant to screen debris to prevent clogging or build-up in the long run of pipe. The alternatives considered for culvert improvements are:

a. The existing culverts may be replaced with one 10 ft x 24 ft arch culvert. During construction, one of the existing 72 inch pipes would be removed and the new culvert put in its place. The second 72-inch drain would remain in place during that time to allow water to continue to flow down the Muddy River. At the completion of constructing the new culvert, the existing drain would be abandoned. Two potential locations of the new arch culvert are shown in Figures 2-9 and 2-10. If the new drain is located to the east side of the existing drain, the headwall at the inlet will require disturbing a large area and will create steep slopes that will require erosion control. This alignment matches up well with the natural channel that matches the historical alignment as described above in Section 2.1.2.1. However, if the new drains are located to the west side of the existing drains, a small area could be left to create an eddy effect, trapping debris in the corner. This alignment matches up well with the natural channel with a modified historical alignment as described above in Section 2.1.2.1. The western alignment also provides more room for bike and pedestrian paths on the east side of the daylighted channel.

b. More capacity at The Riverway also can be created by retaining the current twin 72 inch drains and adding one 10 ft x 16 ft arch culvert alongside the existing drains. The existing drains would be maintained and protected during and after construction. See Figures 2-11 and 2-12. If the new drain is located to the east side of the existing drains, the headwall at the inlet would require disturbing a larger


Arch Culvert
Pile CAP concrete slab spaced along length of culvert
Footing (TYP)
Pile (TYP)
Box Culverts
Pile (TYP)
Pile CAP continuous along length of box culverts

Not to Scale

Figure 2-8
Arch Culvert Vs. Box Culvert Detail

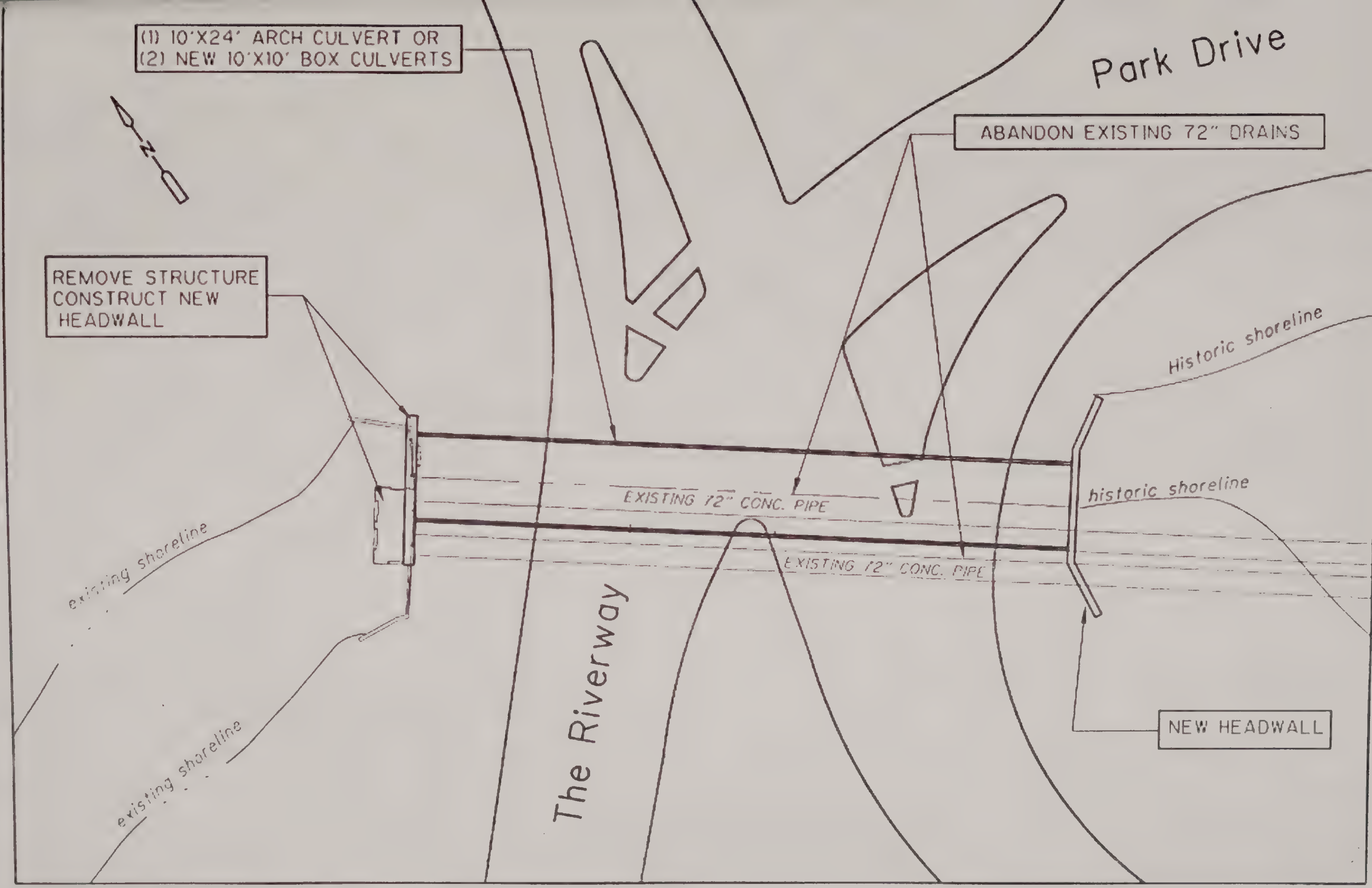


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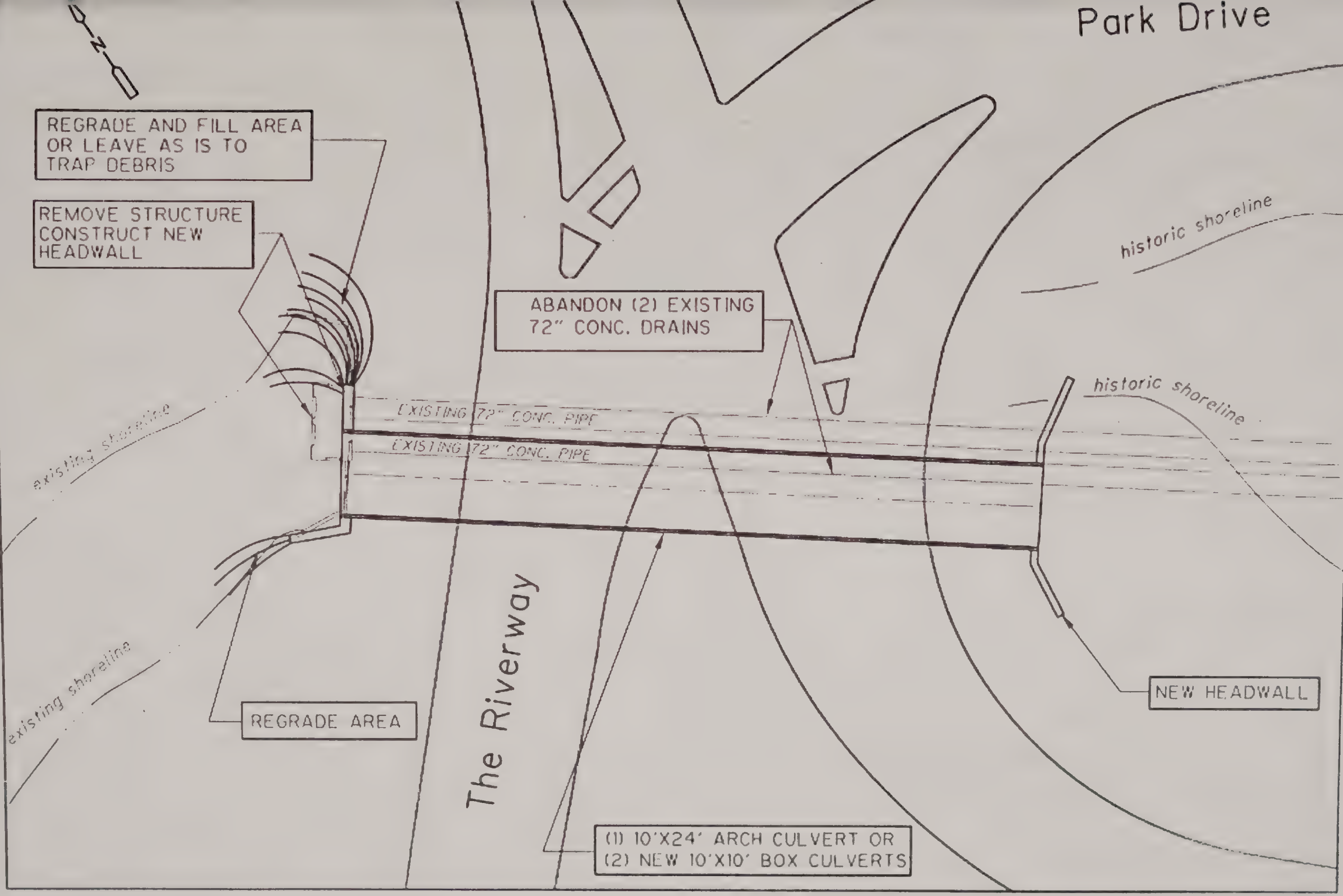
Figure 2-9
Riverway Proposed Improvements
Culvert Replacement-East Side


Park Drive
N
REGRADE AND FILL AREA OR LEAVE AS IS TO TRAP DEBRIS
REMOVE STRUCTURE CONSTRUCT NEW HEADWALL
historic shoreline
ABANDON (2) EXISTING 72" CONC. DRAINS
historic shoreline
EXISTING 72" CONC. PIPE
EXISTING 72" CONC. PIPE
existing shoreline
existing shoreline
The Riverway
REGRADE AREA
NEW HEADWALL
(1) 10'X24' ARCH CULVERT OR
(2) NEW 10'X10' BOX CULVERTS

Not to Scale

Figure 2-10
Riverway Proposed Improvements
Culvert Replacement-West Side

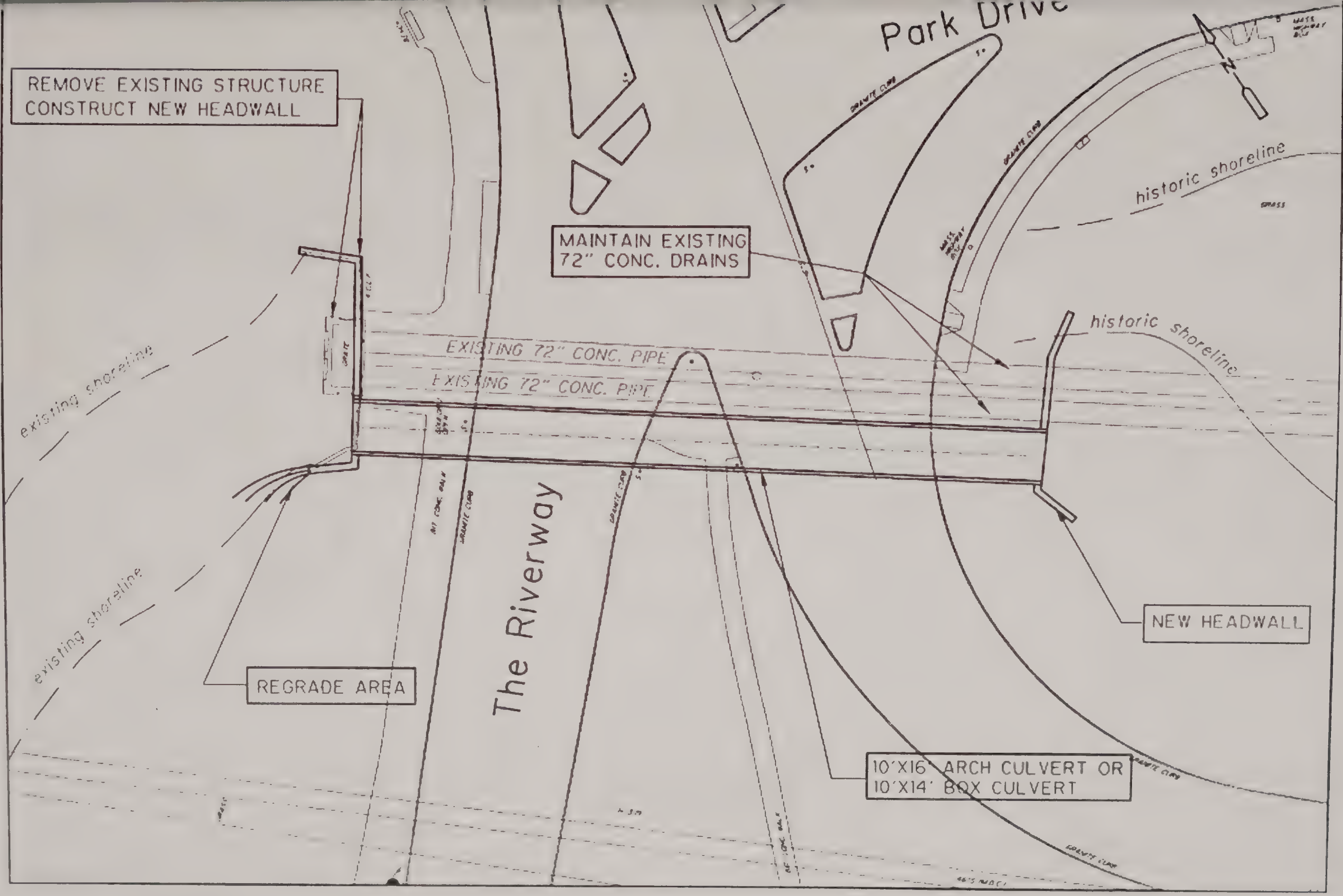


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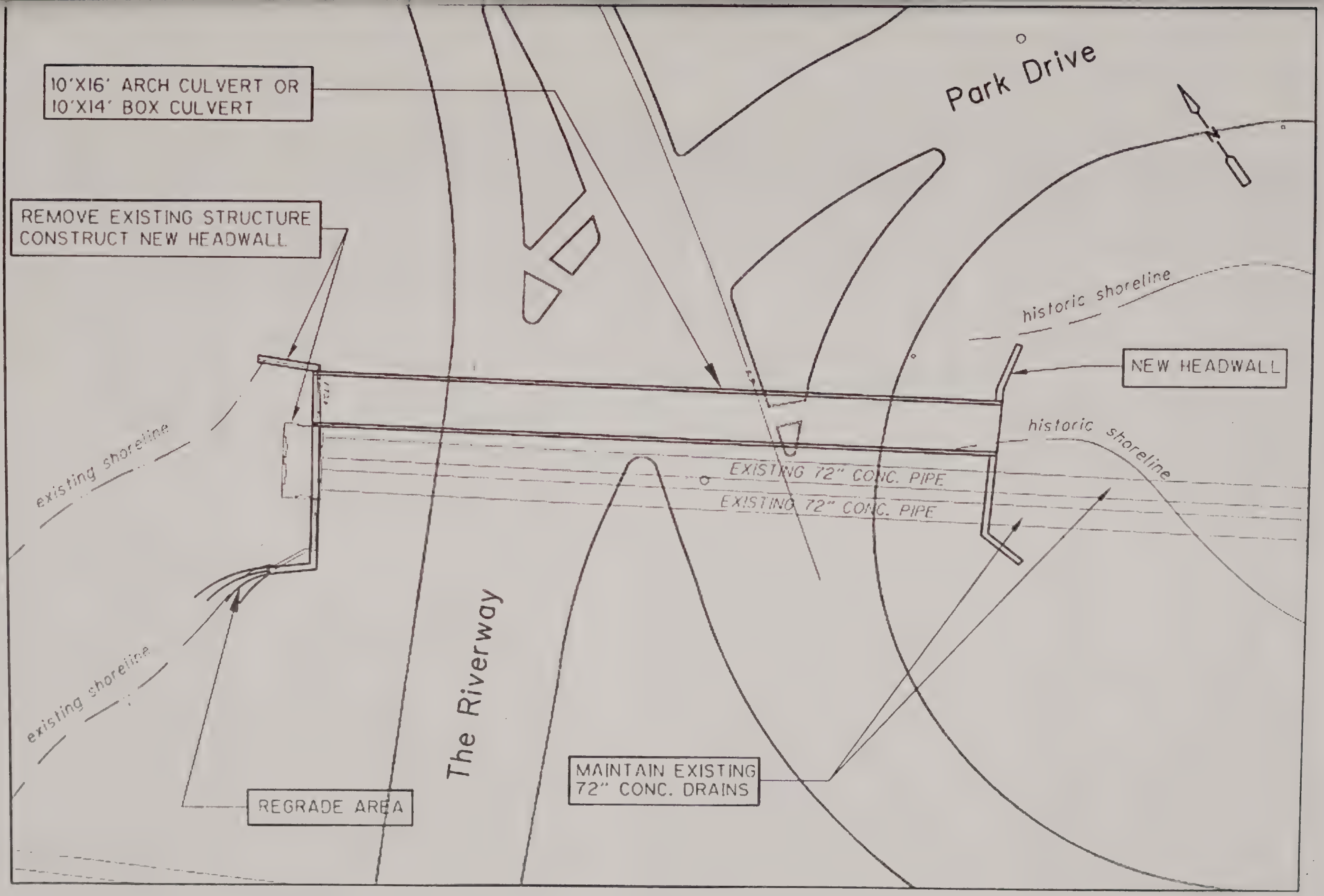
Figure 2-11
Riverway Proposed Improvements
Culvert Enlargement-West Side



Not to Scale

Figure 2-12
Riverway Proposed Improvements
Culvert Enlargement-East Side

area and will create steeper slopes that will require erosion control. This alignment matches up well with the natural channel that conforms to the historical alignment as described above in Section 2.1.2.1. If the new drains are located to the west side of the existing drains, a small area could be left to create an eddy effect, trapping debris in the corner. This alignment is compatible with the natural channel with a modified historical alignment as described above in Section 2.1.2.1.

The proposed culvert improvement at The Riverway would be a 10-ft x 16-ft arch culvert parallel to the twin 72-inch drains on the west side. This improvement is less costly, and easier to maintain and allow more room for bike and pedestrian paths adjacent to the daylighted channel.

Brookline Avenue (Next to the former Sears parking lot)

The Brookline Avenue Gatehouse receives the two existing 72-inch diameter concrete drains from The Riverway and discharges through two drains, the 9-ft x 11 ft Muddy River Conduit and a 7 ft x 9 ft pipe. The 7 ft x 9 ft oval brick drain discharges to the Upper Fens Pond while the Muddy River Conduit discharges to the Charles River. In 1999, improvements were made to the Gatehouse and a large rectangular shaped butterfly valve was installed while an overflow weir to the Muddy River Conduit within the Gatehouse was removed. Currently, the butterfly valve is left open allowing a 50/50 split in flow between the 7 ft x 9 ft drain and the Conduit. In addition, there is sufficient clearance above the valve to allow water to overflow and enter the Muddy River Conduit in a high water condition. A schematic of the Brookline Gatehouse is shown in Figure 2-13.

The 7 ft x 9 ft drain runs under Brookline Avenue and connects to two 72 inch concrete drains that outlet below the water surface at the Upper Fens Pond. Construction drawings of the 7 ft x 9 ft drain shows 45 inch diameter cast iron pipe and the 51 inch x 51 inch brick Emmanuel College drain (a BWSC pipeline) cutting through the top of the 7 ft x 9 ft drain, contributing to additional restrictions in the system. It also appears from the construction drawings that the drain was set at an elevation below the Muddy River downstream, creating a "sump" in the system. It is proposed to replace the existing 7 ft x 9 ft drain with one 10 ft x 24 ft arch culvert using the cut and cover method. The new 10-ft x 24 ft arch culvert would start at the daylighted section of the former Sears parking lot and discharge at the Upper Fens Pond after passing under Brookline Avenue.

The Muddy River overflows to the Muddy River Conduit via the Brookline Gatehouse as discussed above. Hydraulic modeling was performed in order to determine whether the overflow is necessary (see Appendix E). The results show that an overflow to the Muddy River Conduit needs to remain and give relief to the system in large storm events. The following are alternatives to constructing the overflow.

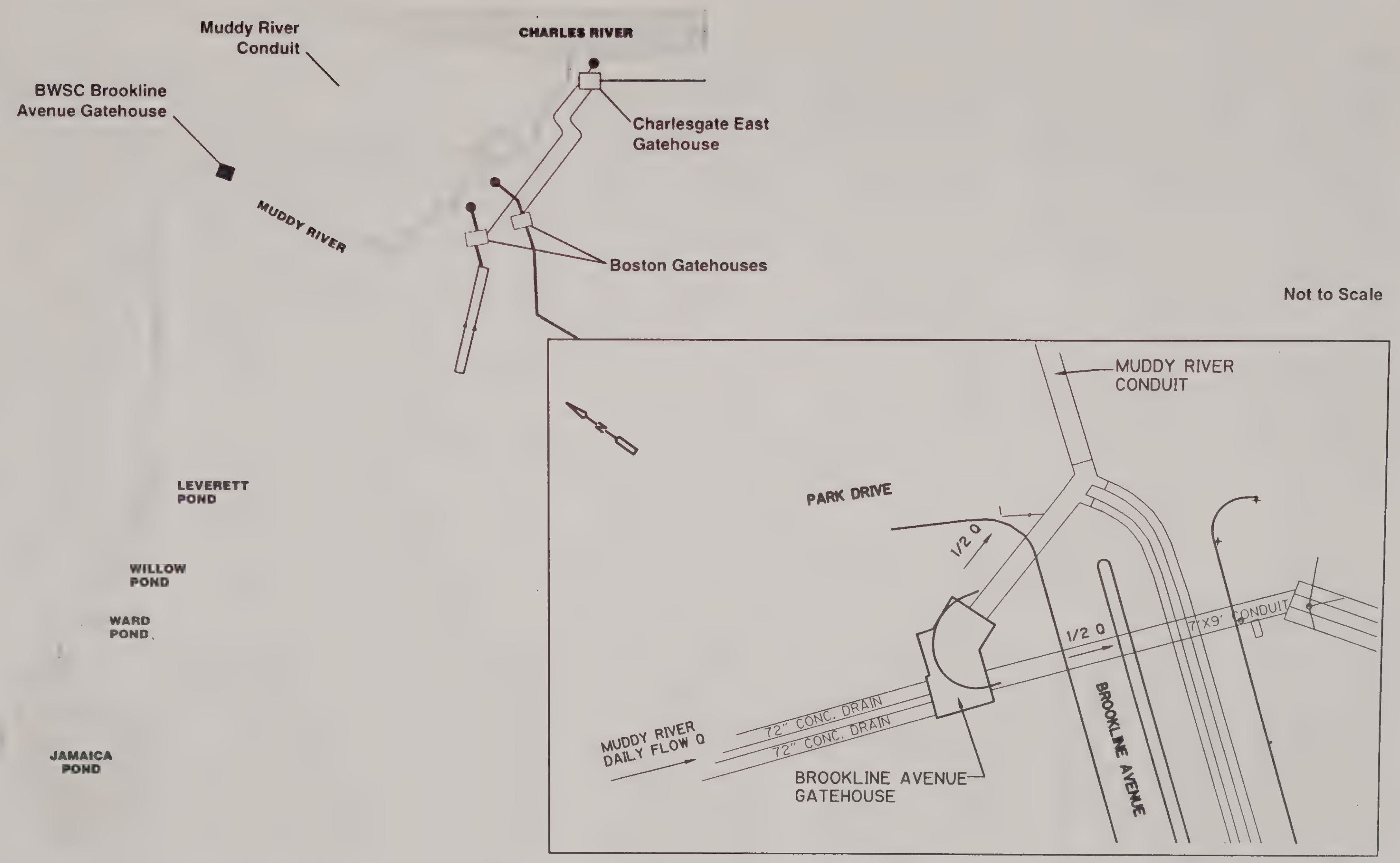


Figure 2-13
Flow Schematic of Brookline Avenue Gatehouse

a. Uncover the face of the Brookline Gatehouse in the daylighted former Sears parking lot. The face of the Gatehouse contains several openings used for flow diversion in the original design. The current twin 72-inch drains would be removed and the openings reused as originally designed (See Figure 2-14).

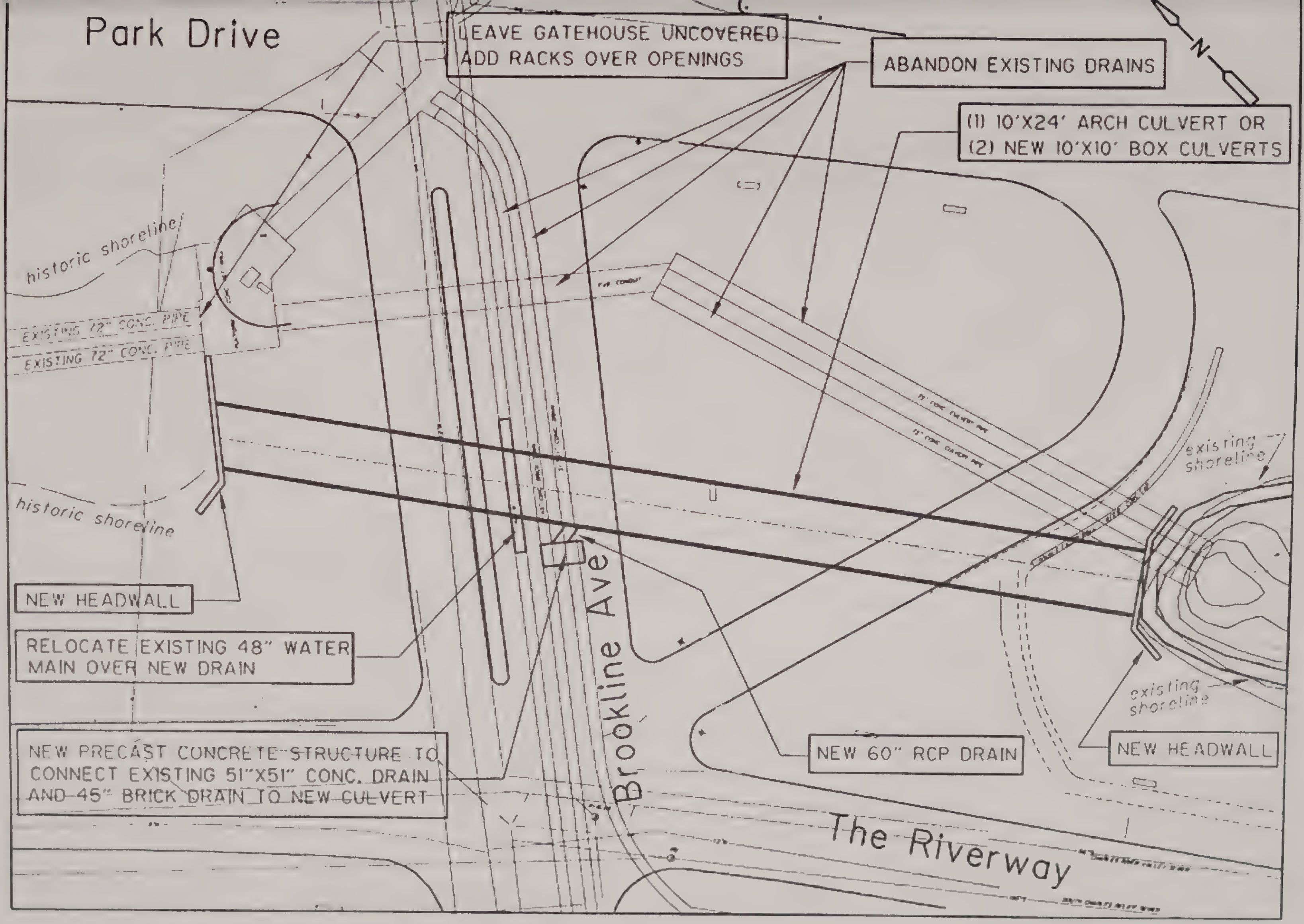
   There are several disadvantages to reusing the original design. First, the openings would need to be protected with a trash rack or the openings submerged. Both of these conditions add significant maintenance and safety issues. Second, from a historic perspective, the substructure with the openings at the water surface were once part of a much larger superstructure which has since been removed. There is little need to restore the substructure that no longer has the more significant superstructure.

b. Another alternative to providing the overflow is to leave a small portion of the 72 inch drains, create a headwall for the two pipes in the daylighted area, and maintain flow into the gatehouse as currently exists (see Figure 2-15). The U.S. Army Corp of Engineers suggested this alternative in their 2000 report . The Gatehouse could then be left covered. However, creating a headwall in the proposed channel would require additional grading and it would be visible from the banks, detracting from the natural appearance of the channel.

c. The last alternative to providing the overflow is to close and fill over the openings at the Gatehouse and use either a new culvert or the existing discharge drain for the overflow to the Muddy River Conduit. The 7 ft x 9 ft drain would be used as an overflow in the reverse direction from Upper Fens Pond. An additional sub-alternative would be to add a direct connection from the new culvert to the Brookline Avenue Gatehouse.

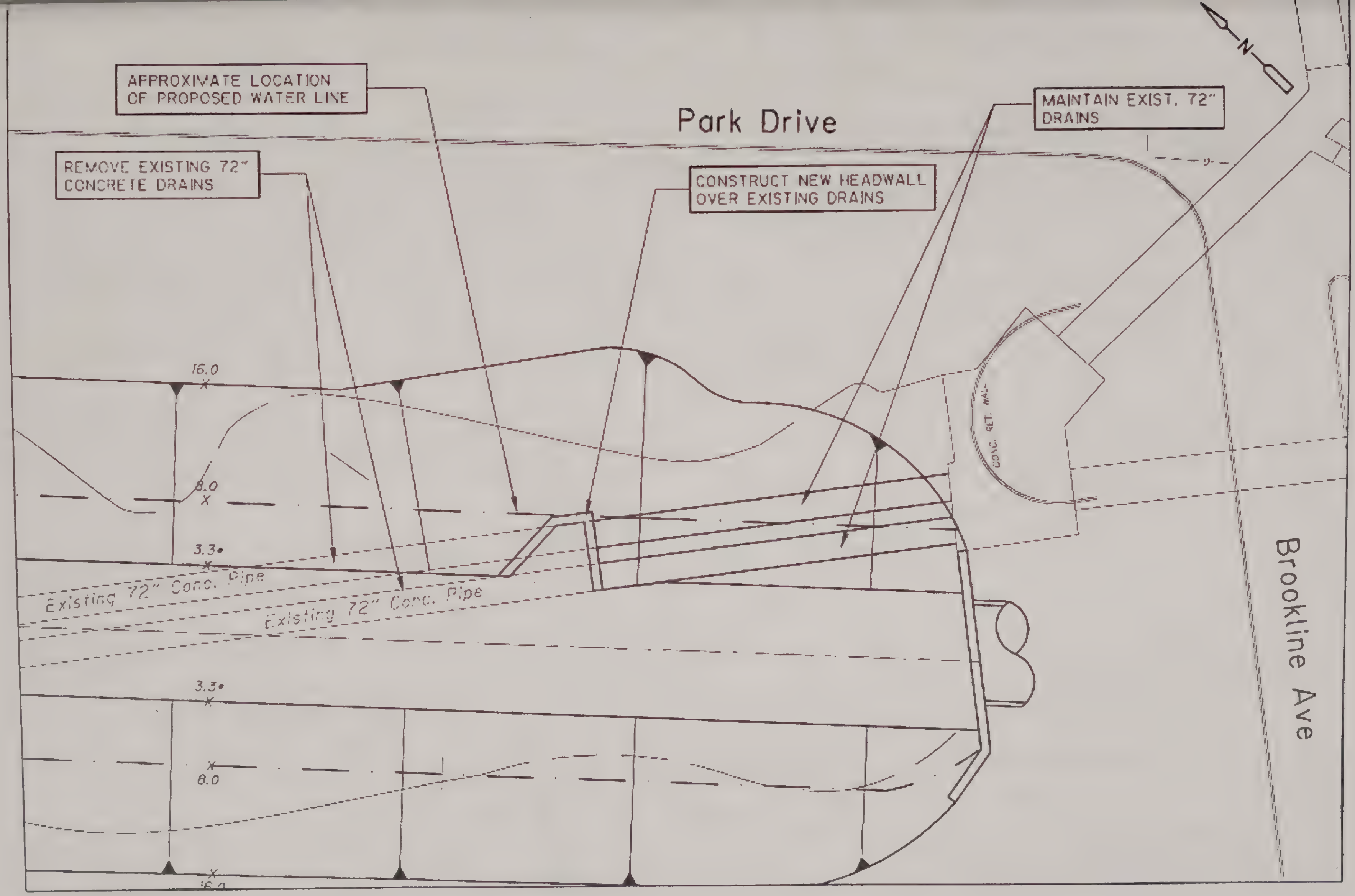
   1. Using the existing 7 ft x 9 ft drain as an overflow is less expensive. It eliminates the need to open the Gatehouse face and makes use of the existing pipelines (See Figure 2-16). However, a headwall is required where the drain outlets to the Upper Fens Pond. The existing pipes would need to be protected and the headwall constructed around the existing pipes. Another disadvantage is the operation and maintenance. Sedimentation will occur in the 7 ft x 9-ft drain and would need to be periodically cleaned. Also, this is a very old pipe, that will require an investigation of its structural stability prior to reuse. The investigation would determine the conditions of the drain and whether it can be reused. From a hydraulic perspective this alternative requires storm water to back up in Upper Fens Pond and reverse flow into the 7 ft x 9ft drain. This is not the most efficient flow pattern.

   2. The second sub-alternative to creating an overflow in the system is to connect the new culvert under Brookline Avenue directly to the Gatehouse (Figure 2-17). A direct connection between the Gatehouse and the new culvert has three advantages. First, it's better hydraulically by not requiring reverse flow, and the water has less distance to travel before it overflows. Second, placing the



Not to Scale

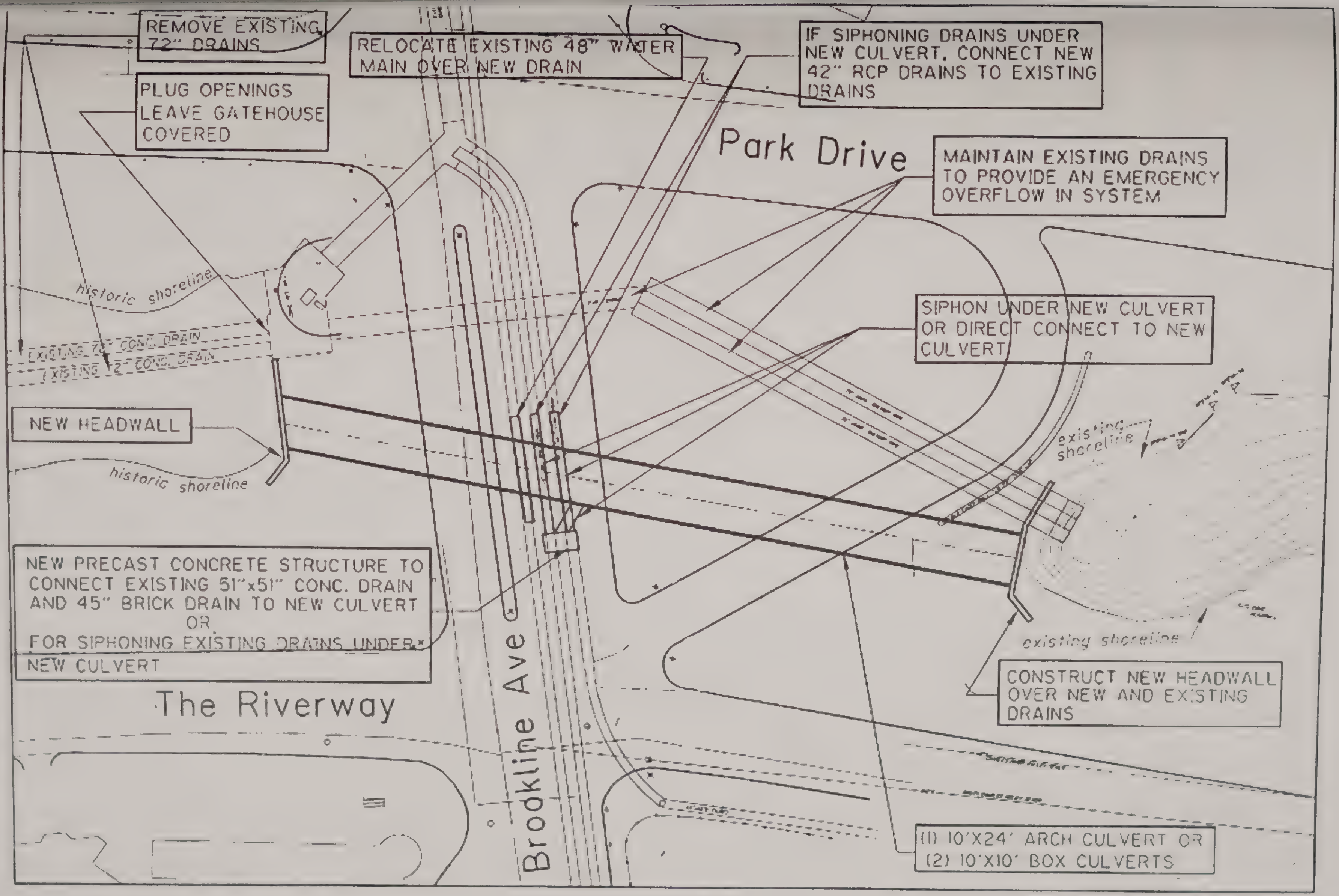
Figure 2-14
Brookline Avenue Proposed Improvements
Open Face of Gatehouse to Provide Overflow-Abandon Existing Drains


APPROXIMATE LOCATION OF PROPOSED WATER LINE
REMOVE EXISTING 72" CONCRETE DRAINS
Park Drive
CONSTRUCT NEW HEADWALL OVER EXISTING DRAINS
MAINTAIN EXIST. 72" DRAINS
N
16.0
8.0
3.3
Existing 72" Conc. Pipe
Existing 72" Conc. Pipe
3.3
8.0
16.0
CONC. RET. WALL
Brookline Ave

Not to Scale

Figure 2-15
ACOE Proposed Improvements to Provide Overflow to Brookline Gatehouse

CDM Camp Dresser & McKee Inc.


REMOVE EXISTING 72" DRAINS
PLUG OPENINGS LEAVE GATEHOUSE COVERED
RELOCATE EXISTING 48" WATER MAIN OVER NEW DRAIN
IF SIPHONING DRAINS UNDER NEW CULVERT, CONNECT NEW 42" RCP DRAINS TO EXISTING DRAINS
Park Drive
MAINTAIN EXISTING DRAINS TO PROVIDE AN EMERGENCY OVERFLOW IN SYSTEM
historic shoreline
EXISTING 72" CONC. DRAIN
EXISTING 72" CONC. DRAIN
SIPHON UNDER NEW CULVERT OR DIRECT CONNECT TO NEW CULVERT
NEW HEADWALL
historic shoreline
existing shoreline
A
A
NEW PRECAST CONCRETE STRUCTURE TO CONNECT EXISTING 51"x51" CONC. DRAIN AND 45" BRICK DRAIN TO NEW CULVERT OR FOR SIPHONING EXISTING DRAINS UNDER NEW CULVERT
existing shoreline
CONSTRUCT NEW HEADWALL OVER NEW AND EXISTING DRAINS
The Riverway
Brookline Ave
(1) 10'X24' ARCH CULVERT OR (2) 10'X10' BOX CULVERTS

Not to Scale

Figure 2-16
Brookline Avenue Proposed Improvements
Use Existing Drains to Serve as Flow

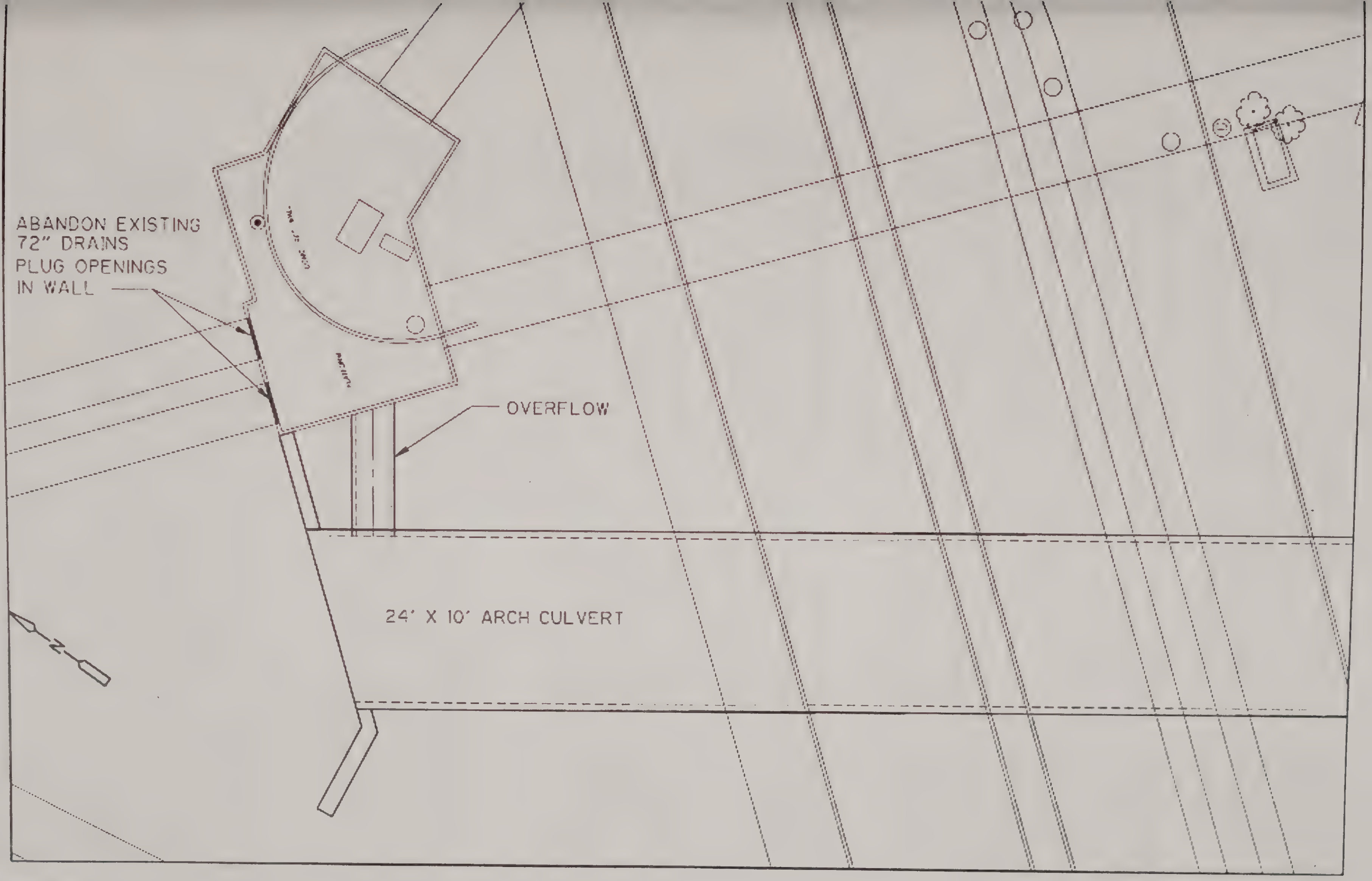


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Figure 2-17
Brookline Avenue Proposed Improvements
Direct Overflow Connection to Gatehouse

connection near the opening to the new culvert would make it easier to maintain and remove sediment accumulation. Lastly, the 7 ft x 9 ft existing drain which risks collapse because of age can be abandoned. The disadvantage is that this option will require major reconstruction of the Gatehouse. Modifications to the Gatehouse will be expensive.

An additional problem to be addressed in Brookline Avenue culvert construction is the connection of the 45 inch Brookline Avenue drain and 51 inch by 51 inch Emmanuel College drain. These drains currently restrict the flow in the 7 ft x 9 ft main drain and would also impact the proposed new 10 ft x 24 ft arch culvert. It is not crucial that the drains flow to the Muddy River Conduit. The BWSC, in a meeting with Boston Parks on September 5, 2000, did not see any problem with diverting the drains to the Muddy River provided there were no adverse hydraulic impacts. Modeling was performed to determine the impact of these drains on the Muddy River system (see Appendix E). The result shows that the Muddy River is impacted very little by the addition of these drains during heavy storms and the flow in the Muddy River Conduit would be reduced.

The method recommended to connect the two drains to the 10 by 24 foot culvert would be to construct a cast-in-place manhole structure over the two drains and connect the manhole to the new culvert with a short section of 60 inch diameter pipeline. Details of this connection are shown in Appendix I.

Another method to handle the Brookline Avenue and Emmanuel College drains would be to construct siphons under the new arch culvert and maintain the connection to the Muddy River Conduit. This option would not increase flows to the Muddy River. Siphons for these pipelines would create a costly and difficult operation and maintenance issue. The BWSC does not view a siphon favorably and it has been dropped from consideration.

Avenue de Louis Pasteur (Fens Bridge)
There is a culverted 16-ft wide brick arch sitting on large rectangular stone blocks under Avenue de Louis Pasteur. The face of the culvert at the outlet consists of large pudding stone stacked and sloping outward, typical of other culverts in the Emerald Necklace. Hydraulic modeling indicated that the capacity of this culvert is insufficient to carry flows during a design storm. Three alternatives exist to achieve the necessary capacity.

a. The first alternative is to restore the upstream and downstream headwalls and dredge the bottom of the culvert. The topographical survey indicates that approximately 2-1/2 feet of sediment accumulation must be removed. If the sediment is removed, the culvert would have the necessary flow capacity. This alternative, as shown in Figure 2-18, is the most cost efficient, and would cause the least amount of disturbance of roadway traffic, banks and wetland areas.

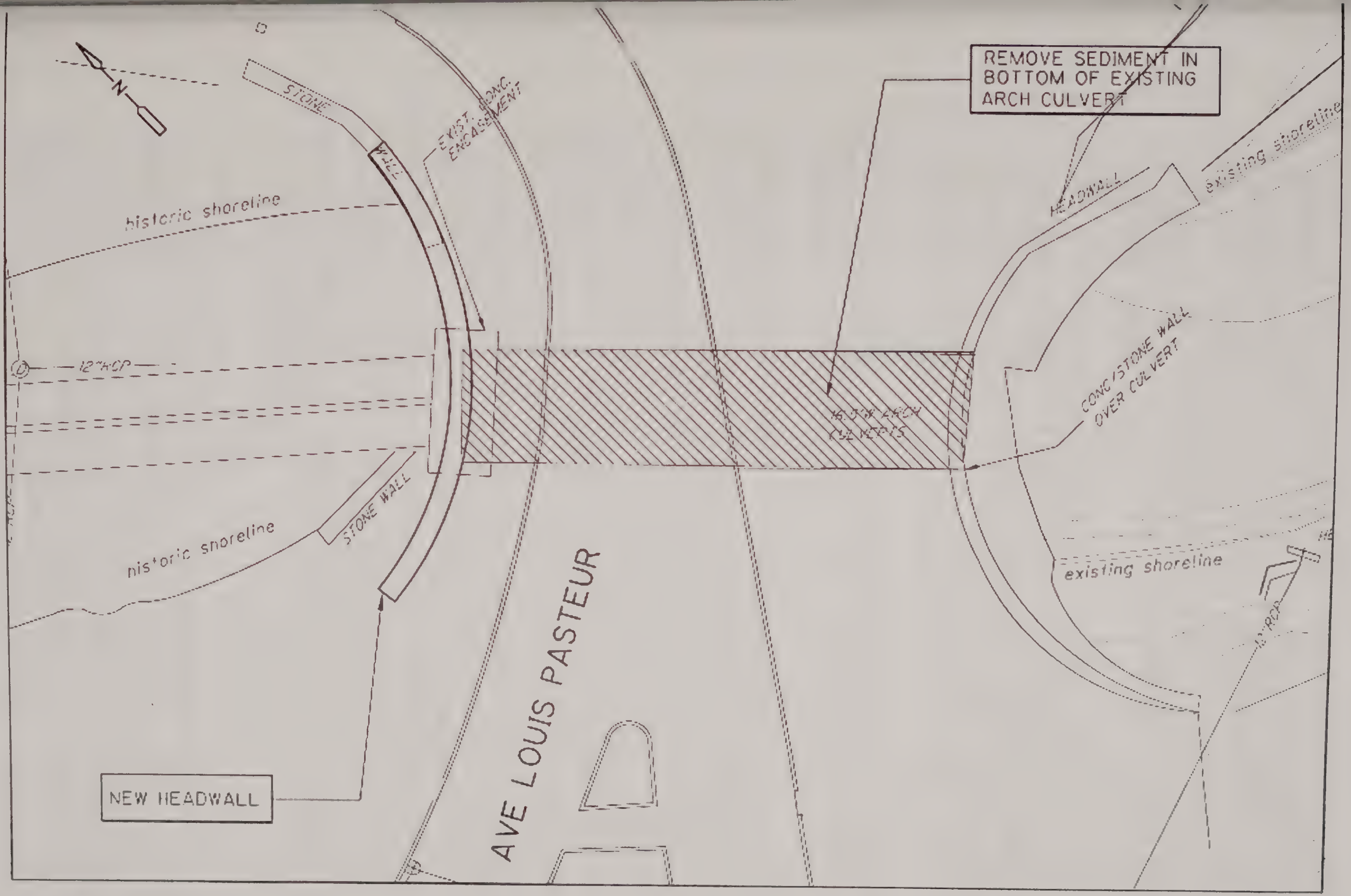

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Figure 2-18
Avenue Louis Pasteur Proposed Improvements
Dredge Existing Culverts

b. A 5-ft x 8-ft box or 4 ft x 12-ft arch culvert, as shown in Figure 2-19, could be constructed alongside the existing culvert to compensate for the loss of capacity due to sediment build-up. This option would require reconstruction of the pudding stone headwall on the downstream side. Because the pudding stone face is setback, it would be difficult to excavate and reconstruct without removing a large portion of the headwall. The difficulty of construction would add dramatically to the cost. This alternative is costly with only a small net gain in hydraulic capacity.

c. The last alternative would be to replace the existing culvert with two 10 ft x 10-ft box culverts or one 10 ft x 24 ft arch culvert as shown in Figure 2-20. This option would require major reconstruction and replication of the two pudding stone headwalls. This option is the most costly and it increases the time of construction in the roadway and wetlands. As with the parallel culvert this alternative is costly for a small net gain in hydraulic capacity.

The alternative to retain the existing Fens Bridge culvert, reconstruct the upstream headwall, repair the downstream headwall and dredge the culvert is most cost effective and historically consistent.

Therefore, the conclusion of this portion of the flood control alternatives analysis is that only through a combination of alternatives that include daylighting of culverted sections of the Muddy River, enhancement of culvert capacity through enlargement and replacement, and diversion of the Brookline Avenue and Emmanuel College drain, would the goal of restricting the design storm to elevation 15 (BCB) be attained. While the various infrastructure improvements would eliminate the flow constriction through this section of the Muddy River, they would not address the problem of insufficient cross-sectional flow area downstream of the culverts. Improvements between the Riverway and the Fens Bridge would release more flow downstream and worsen the existing conditions where the cross sectional area is too small to allow the passage of the design storm flow without flooding. Section 2.1.3. (Increase Upstream Storage) and 2.1.4 (Flood Proofing of Property) contain descriptions of several sub-alternatives to implement the infrastructure improvements. All of these sub-alternatives are hydraulically equivalent as each is designed to pass and design storm flows. The infrastructure improvement alternatives has been treated as a single alternative since all the sub-alternative variations address the objective of flood control for the portion of the Muddy River from the Riverway at the former Sears parking lot to the Fens Bridge.

2.1.3 Increase Upstream Storage

This alternative is being considered to reduce the volume of flood waters in the Muddy River drainage basin reaching the culverts and river sections with insufficient flow capacity. Upstream storage provides capacity to hold storm waters until they can be released downstream at a later time to reduce flooding impacts. The storage needs to have two elements; first the storage must be of sufficient volume to hold flood flows for later release and second, the storage must be capable of delaying the

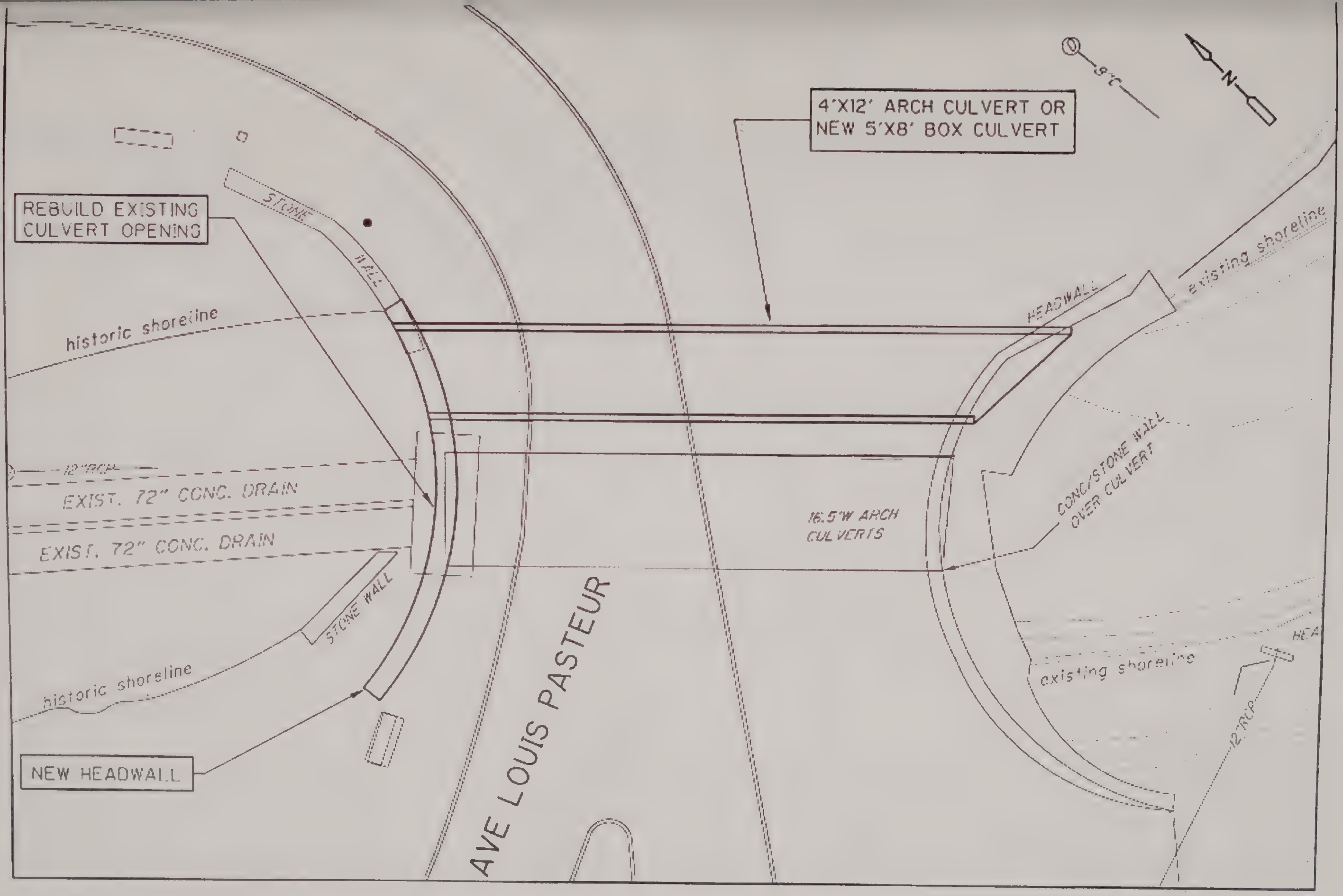

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Figure 2-19
Avenue Louis Pasteur Proposed Improvements
Culvert Enlargement

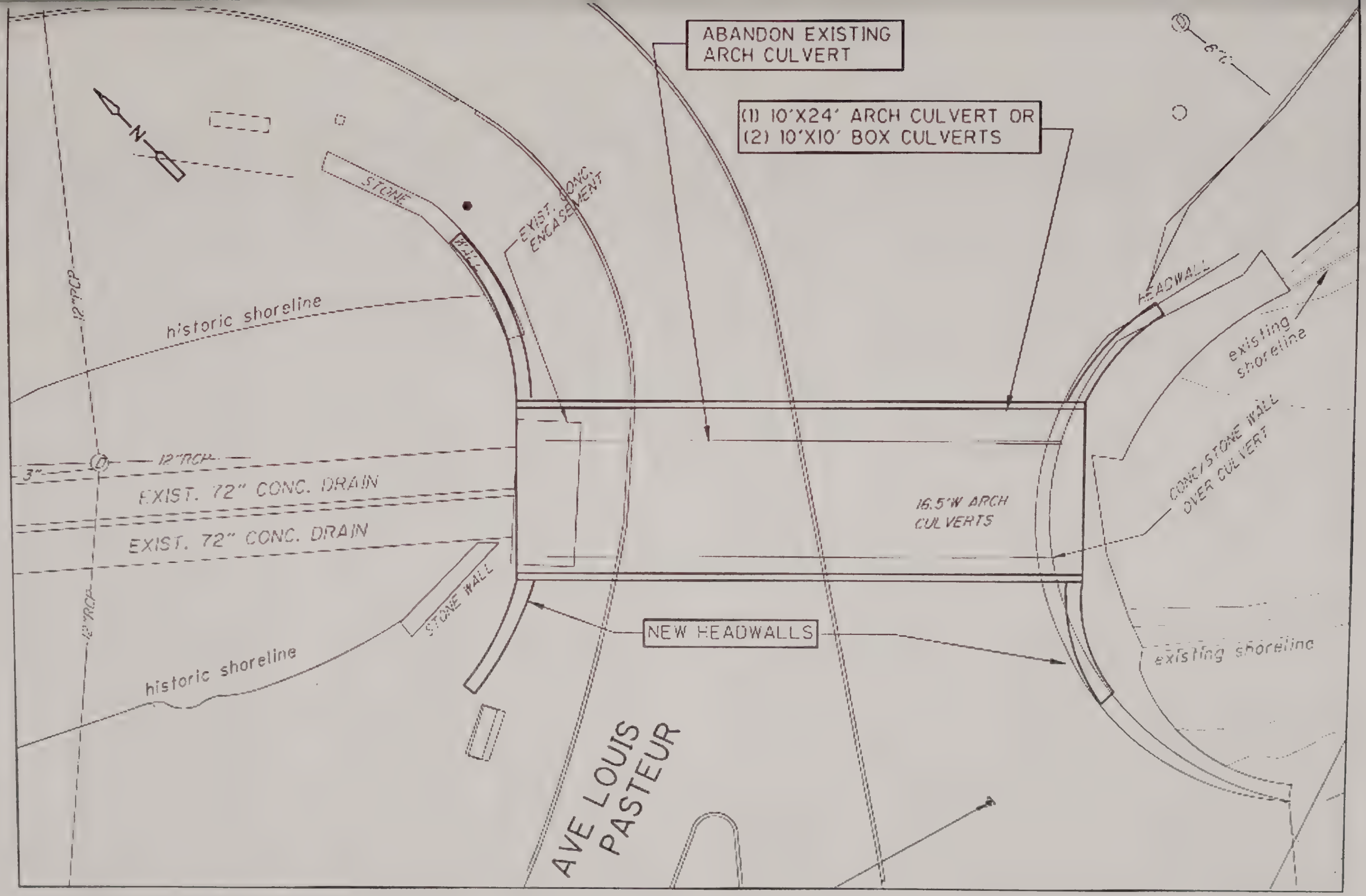

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Figure 2-20
Avenue Louis Pasteur Proposed Improvements
Culvert Replacement

release so that the stored water reaches the constricted sections at a time when the flooding is receding.

The design storm for the Muddy River results in an excess flow over the hydraulic capacity of the facilities of 170 million gallons (mg). This means that there are 170 MG of flow that can not be accommodated with in the capacity of the culverts or channel sections. The level of flooding is related to the surge created by this 170 mg.

Upstream storage was evaluated by looking at the first element of storage – sufficient volume. In order to store 50% of the excess flow a volume equivalent to 3 feet in depth over 9 Leverett Ponds would have to be provided. Expressed in another way, if two feet in elevation was added to the existing Leverett Pond only 0.06% of the excess flow would be retained. This also be equivalent to about 360,000 cisterns located in the watershed. In the urban watershed like the Muddy River there are not sufficient locations available to store sufficient volume to effectively change the storm flooding at problem structures or problem river sections. This alternative has been eliminated from further consideration as a primary flood control alternative.

As a policy all communities in the watershed should be encouraged to provide storm water storage where possible since this would reduce the effects of smaller storms. These policies might encourage individual cisterns, disconnecting downspouts from storm drains and providing retention swales in new or refurbished construction development projects.

2.1.4 Flood Proofing of Property

One alternative under flood control would be to flood proof property damaged by the design storm. The purpose of flood proofing is to construct berms, or dikes, modify storm pipelines or flood protect individual buildings to prevent damage. Under some circumstances the property damage is sufficiently isolated that the cost to protect property is low compared to the damage and therefore is a feasible alternative.

The alternative of flood proofing the MBTA subway including Kenmore station was considered. The subway flooding entered the tunnel from the portal ramp located just north of Park Drive. A flood proofing concept, developed by the Army Corps, included stop logs or a gate to close over the trackway before floodwaters reach the area. It also involved raising the sidewalls at the portal to an elevation above the flood stage.

The Army Corp study found that this approach could keep floodwaters out of the tunnel, but only at the cost of flooding other properties. Floodwaters would inundate adjacent commercial properties and the CSX rail line along the Massachusetts Turnpike, causing the interruption of CSX, MBTA and Amtrak trains along that route. Furthermore, the use of the stop logs or gate at the Park Drive portal would also result in the suspension of Green Line service along the Riverside Branch. In addition, this approach does not lower flood levels. With the 1996 flood, if 30 million gallons had not flooded the tunnel, these 30 million gallons might have caused the flood stage elevation to be higher.

Since flood proofing does not lower the flood stage, it does not address the other flood problems experienced by residents, institutions and businesses in Boston and Brookline. It does not prevent significant park areas and roadway from being inundated and damaged. Even less severe flood events would continue to overflow banks and damage parkland, habitat, and historic features along the river. The purpose of the historic design of the Muddy River Sanitary Improvement in the 1890s was to provide adequate flood capacity. This has been lost due to culverting of sections of the river and sediment build-up. Only addressing the root cause of the flooding will remediate conditions for all parties impacted by the major floods of recent years.

Finally, flood proofing does not address any other of the project objectives: it does not improve water quality, enhance habitats, provide for historic rehabilitation of the park, or implement BMPs. Since flood proofing does not address any project objectives, it was not considered for the recommended alternative.

2.1.5 Dredging

The dredging alternative could include either partial or full dredging of various sections of the Muddy River in order to increase hydraulic capacity. Three dredging alternatives were evaluated and included; dredging of the Charlesgate area only, dredging of a channel though the Back Bay Fens, dredging of the Riverway, and bank-to-bank dredging. The partial dredging alternatives, i.e. dredge Charlesgate, dredge a channel through the Back Bay Fens, and dredging of the Riverway involve only the removal of accumulated sediments within the area that is under water. The full or bank to bank dredging alternative would involve the removal of all accumulated sediment plus total removal of the *Phragmites* root mass to facilitate control of this invasive plant. The dredging alternative would require the use of staging areas along the Muddy River in order to accommodate construction trailers, dewatering equipment, and other appurtenances. The following sections of this EIR include discussions of dredging methodology, options for management of the dredge materials, and an evaluation of potential staging areas along the Muddy River.

2.1.5.1 Alternative Dredging Methods and Dredged Material Management

Dredging and dewatering of sediments can be performed either by mechanical dredging methods combined with stockpiling and air-drying dewatering, or by hydraulic dredging combined with mechanical dewatering. The different methods of dredging and dewatering and the impacts of each method are discussed below.

Mechanical Dredging

Three mechanical dredging methods were evaluated for the Muddy River: dragline dredging, environmental clamshell bucket dredging, and dredging with barge-mounted excavators. Wherever possible, the dredging equipment used for each method would be barge mounted and operated from the river to minimize bank disturbance. Details of each of the three methods are discussed below.

Dragline Dredging

Dragline dredging consists of a crane-mounted barge with a bucket attached to the crane boom by cables. The boom swings to position the bucket, which is then lowered and dragged horizontally across the sediment until it is full. The cables are used to maneuver the bucket as it is pulled horizontally and to open it so that the dredged material can be emptied onto a spoils barge or into a truck.

The use of a dragline requires sufficient height clearance for the crane and for the swinging of the boom; therefore trees along the riverbank might need to be removed. In addition, the dragging of the bucket makes removal depths less precise and increases the suspended solids in the water. Sufficient bank vegetation would need to be cleared in each section of the river to provide access for the barge and crane, and any spoils barge or trucks. Dragline dredging is typically used in large, open water projects.

Environmental Clamshell Dredging

Environmental clam shell dredging consists of a barge-mounted crane that is fitted with an environmental clam shell bucket. The boom positions the bucket and lowers it into the sediment. The bucket fills with sediment and closes before it is raised. An example of a barge-mounted crane and clam shell bucket is shown in Figure 2-21.

Environmental clam shell dredging is used where protection of water quality and minimization of turbidity are important. The environmental clam shell bucket differs from a traditional bucket due to the following features:

- Overlapping side plates to reduce lateral movement of material;
- A positive side lip sealing system;
- Passive venting to reduce downward pressure in the water column when lowering;
- Top covers to prevent washout and sloughing when raising;
- A clam shell bucket lock to avoid accidental discharge of bucket contents;
- Clam shell vibrators that remove all dredged material at the receiving barge;
- A large, flat dredge footprint; and
- Horizontal cutting action that provides for a flatter dredge profile and eliminates pockets.

As with dragline dredging, environmental clam shell dredging requires sufficient clearance for the crane. Since the bucket is dropped vertically with this method rather than dragged over a greater lateral area, the crane and the boom would need to be able to maneuver more than with the dragline method. Again, sufficient vegetation would need to be cleared in each section of the river to provide access for the barge and the crane.

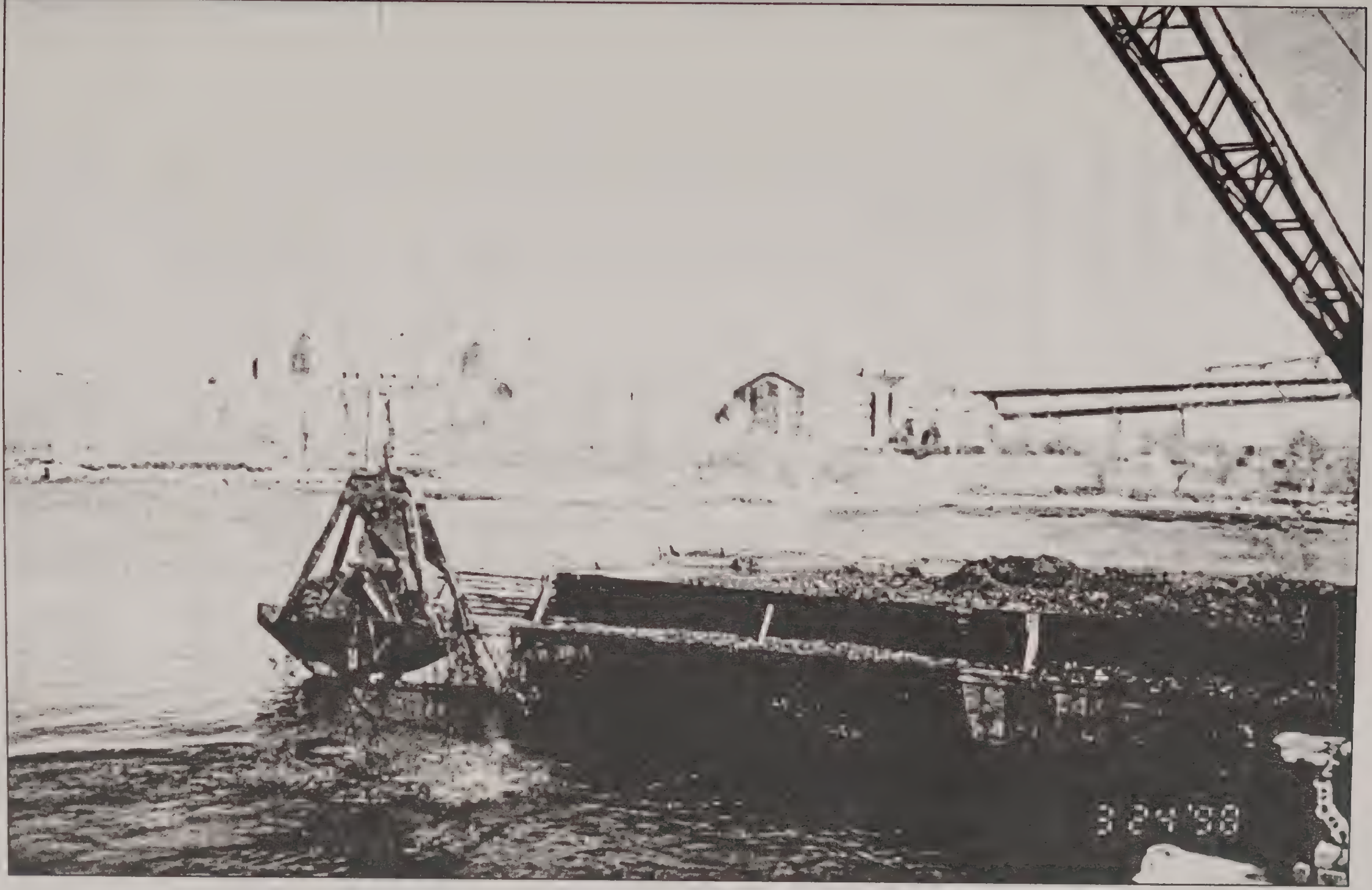


Figure 2-21
Barge-Mounted Crane with
Environmental Clamshell Bucket

Excavator Dredging

Dredging with a track or wheel-mounted excavator consists of a large backhoe mounted on tracks or wheels. The arm of the backhoe is fitted with an open bucket, which is maneuvered by the arm to scoop material out of the river. The backhoe can be fitted with different length arms and different size buckets to increase removal or to increase the reach. For example, a long boom could be utilized to increase the reach, which would minimize the need to move and re-position the excavator

The backhoe is more mobile than cranes; therefore less vegetation would need to be cleared for it to maneuver. In addition, the mechanical arm can position the bucket more precisely than can the cable-maneuvered buckets. This allows for increased precision for removal.

Barge-Mounted Excavator Dredging

In the areas behind the Victory Gardens and War Memorials where there is extensive growth of *Phragmites* and there is adequate space to utilize barges, the alternative was examined to mount an excavator on a barge and using small barges to shuttle the dredged *Phragmites* root mats to shore. This alternative has the advantage of limiting truck and other heavy traffic in such areas as the Victory Gardens and near the War Memorials. An example of a barge-mounted excavator is shown in Figure 2-22.

The dredged sediment would need to be loaded onto spoils barges and transported to temporary docks where it would be off-loaded into watertight trucks for transport to the staging areas. This is a disadvantage in that the material is handled twice. It is time consuming, less efficient, and it increases the likelihood of spills. Additional vegetation would need to be cleared for the dock space and off-loading equipment. The docks would need to be constructed in each segment of the river and haul roads would need to be constructed so that the trucks could access the loading docks. The truck traffic near the river's edge may exacerbate and add to bank disturbance. Using trucks to transport the dredged material to the staging areas would increase truck traffic and the spread of mud and dust on the local roads.

In addition to spoils handling concerns, mechanical dredging would require clearing of vegetation so that the equipment can access the river and maneuver around in it. A substantial portion of the Muddy River is narrow, which restricts mobility, and much of it is surrounded by parkland. In these areas, clearing vegetation would detract from the surroundings and the presence of heavy equipment and truck traffic would reduce public use.

Finally, each of the three mechanical dredging methods has the potential to increase turbidity by re-suspending solids in the water. The motion of the bucket across the sediment during dragline dredging could increase suspended solids as could the fact that an excavator has an open bucket. The environmental clam shell bucket is designed to reduce re-suspending solids, however, if debris gets stuck in the bucket it could prevent the seals from working properly. Water quality is a concern in the

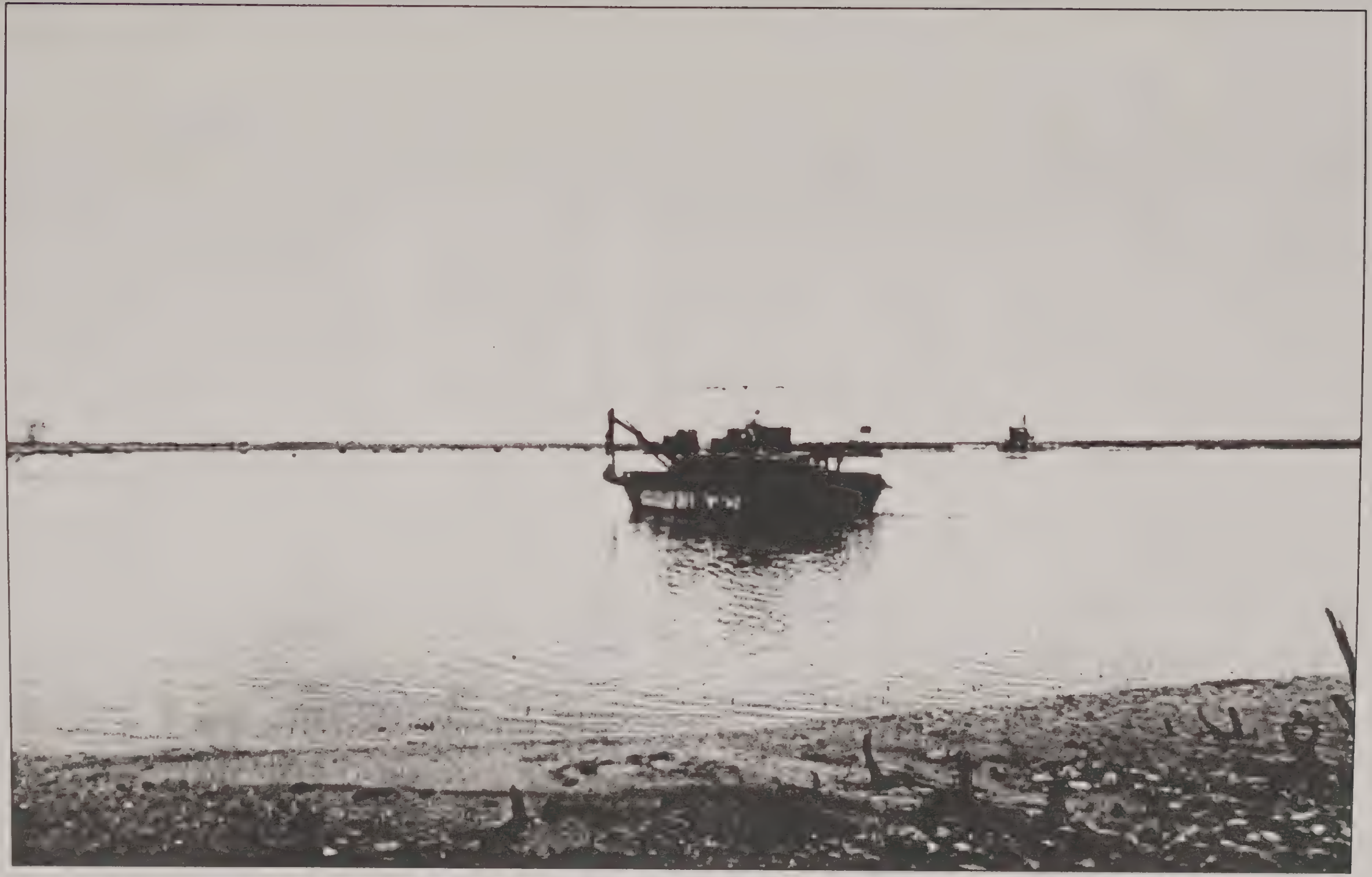


Figure 2-22
Barge-Mounted Excavator

Muddy River; therefore the selected dredging method should minimize suspended solids during dredging operations.

Hydraulic Dredging

Hydraulic dredging involves the use of a barge-mounted suction boom with a mechanically operated cutter head. The boom is positioned at the front of the barge and is angled to the desired dredging elevation. The cutter head sweeps back and forth across the area that is being dredged and cuts the sediment and mixes it with water until it forms a slurry. The slurry is then sucked through a pump mounted on the barge and pumped to a staging area through a pipeline connected to dewatering equipment on shore. Depths can be set so that the proper grades are maintained, and in some cases the cutter head can be fitted with a hood to minimize the amount of sediment that is re-suspended in the water. An example of a hydraulic dredge barge is shown in Figure 2-23.

Dredging equipment can be sized so that it can fit in narrow stretches of the river and operate in shallow water. Since the equipment is small, there is less bank disturbance and less vegetation would need to be cleared to provide river access than with other equipment. The barge can be adapted so that it is low enough to access some culverts and areas under bridges that cannot be accessed with mechanical dredging equipment. A pipeline (typically 6-10 inches in diameter) is constructed from the barge so that the sediment can be pumped from the dredge directly to a dewatering area. Where possible, the pipeline is floated in the water to avoid impacting vehicular and pedestrian traffic by locating it on sidewalks or roads.

Pumping sediments in the pipeline directly to dewatering equipment helps to minimize odors compared to other dredging methods. The sediment is enclosed in the dredge and the pipeline until it reaches the dewatering equipment, thus odor is not a problem during dredging and pumping. To control odor at the staging areas, the dewatering equipment can be covered, if necessary.

Hydraulic dredging is advantageous because the equipment that it used is generally smaller than mechanical dredging equipment. This decreases the impact on the surrounding area and vegetation and also minimizes the disturbance to local residents and businesses. The action of the cutter head, particularly if it is fitted with a hood, does not create a lot of suspended solids because the material is sucked into the dredge. Pumping the sediment directly from the dredge to the staging area reduces vegetative impacts and spills of material that could occur while material is transported after mechanical dredging. It also minimizes the amount of material handling that would be required. Since the sediment mixture can be pumped almost one mile, centralized dewatering areas can be set up. The use of centralized staging areas eliminates the need to clear extensive areas of vegetation along the river and minimizes the impact that dredging operations have on public use of surrounding areas.

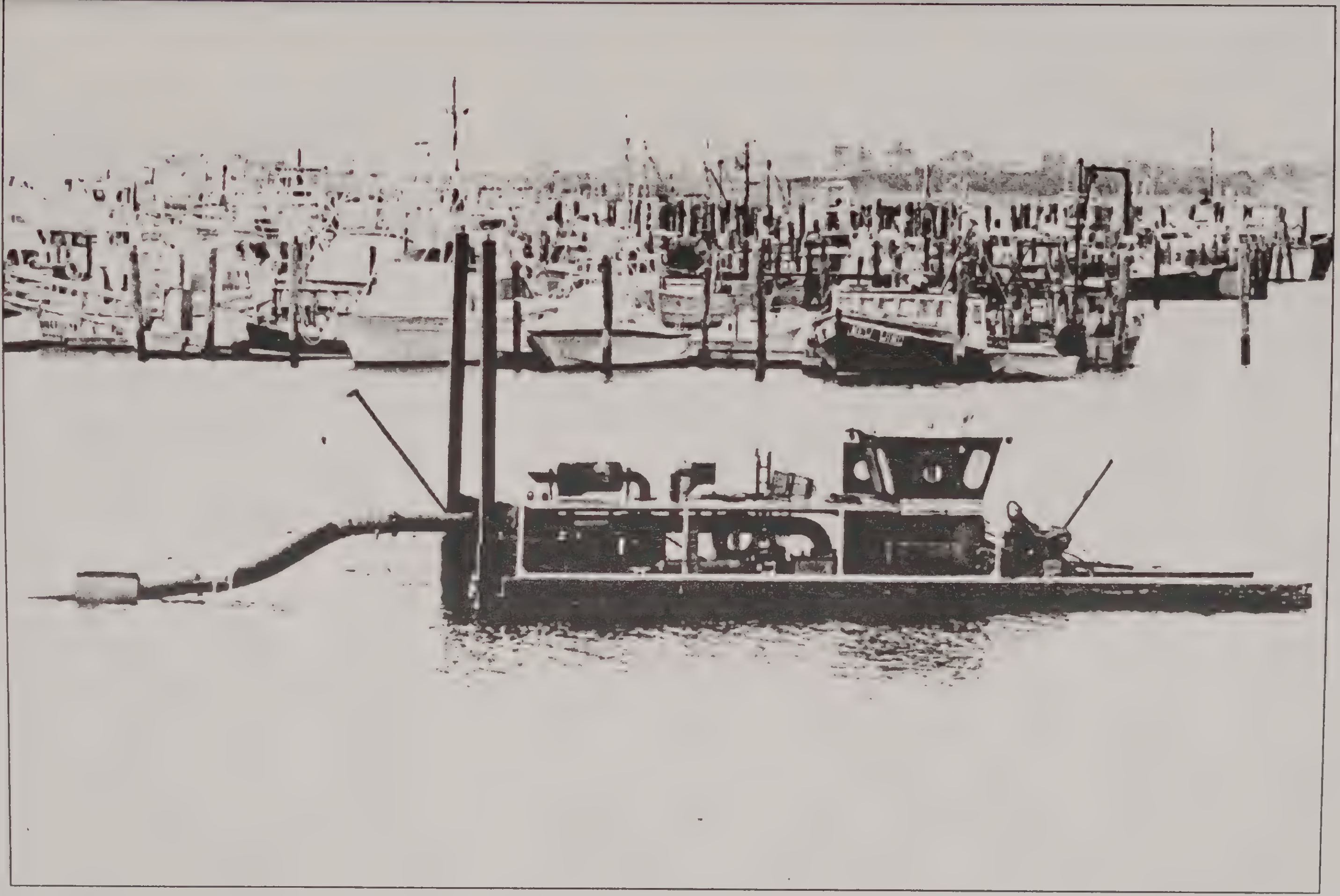


Figure 2-23
Hydraulic Dredge Barge

Phragmites Removal

Phragmites removal along the Muddy River involves several different settings. In many portions of the river the Phragmites has grown out into the water channel and built up a significant root mat. This condition is typified in the area between the Victory Gardens and Mothers Rest where the *Phragmites* has left a very shallow channel of less than 30 feet in width. In other areas the *Phragmites* has moved up the bank and inhabits wetland and bank areas such as the growth at the Back Bay Yard.

Several methodologies are available for removing and control of *Phragmites* including chemical control, killing off with plastic or mechanical removal. The success of the metrologies is somewhat dependent on the density and setting of the *Phragmites.*

Control or removal using chemicals or black plastic does not remove the root mass and leads to significant long-term maintenance. Since the channels need to be cleared of the root mass for flood flow capacity and the root needs to be prevented from re-closing the channel, removal of the root mass in the channel must be a priority. Removal would be accomplished by mechanical means (excavator), and the root mass disposed off-site. *Phragmites* stalks and root mat will be removed using a combination of mechanical methods, regardless of the dredging method that is selected. This material does not contain much excess water; therefore it will be handled separately from the sediments to avoid increasing dewatering needs. The stalks will be cut by small all terrain equipment or by hand where required, mulched, and loaded into small trucks for disposal. A small, barge mounted backhoe or low-impact excavator that can be supported on the root mat would then remove the upper layer of the root mat and load it onto a spoils barge or truck. Care would be taken to minimize mixing the root mat with underlying sediment. Once the root mat is removed, the underlying sediment would be dredged with a hydraulic dredge as discussed above.

Dewatering of Dredged Materials

Two methods for dewatering of dredged materials were evaluated and discussed below. These are placement of the dredged materials into lagoons and allowing air drying to take place and mechanical dewatering with belt filter presses.

Air-Drying/Dewatering of Mechanically Dredged Sediment

The excavated sediment would have to be dry enough to pass the paint filter liquids test so that it can be trucked for disposal in a landfill depending on the chemical analysis of the sediments. Therefore, the sediment would have to be dried/dewatered prior to disposal. The most feasible and common dewatering methods for mechanically dredged material are air drying and bulking with dry material. Mechanical dewatering processes such as belt presses or centrifuges are not well suited for material that has been excavated mechanically because the material needs to be a slurry so that it can be pumped through the conditioning tanks and to the mechanical devises.

For the air-drying method, soils would be deposited in a sloped stockpile that is 4.5 ft high in the center, within a lined, bermed area in the staging area, and allowed to dry for 9 to 12 months depending on the time of year. The remaining material would be stockpiled within the bermed area also until it could be spread out. Since air-drying often cannot be achieved in a reasonable time period, bulking material such as fly ash, hydrated lime or cement would need to be added. Equipment such as excavators or front-end loaders would be used to mix the bulking material with the sediment as it is spread out. This method can increase the volume of material, and therefore the disposal costs by 20% to 60%. Additional costs would be associated with purchasing the bulking material.

Odors are difficult to control with air drying methods. Once the sediment is spread out, there are significant areas for odors to originate. Lime addition or foams are the best methods to control odors at this point.

Air drying the sediment that is dredged from the Muddy River would require a minimum of eight staging areas with dimensions of approximately 400 ft by 200 ft. In addition to the drying area where the material is spread out, the staging area would need truck access and room to unload wet material and load dried material, equipment such as an excavator to unload and spread material and a runoff collection and holding system.

Haul roads would need to be constructed to bring material from the river to the areas. It is estimated that this process would require 3 to 5 10-wheel dump trucks cycling a total of 50 times per day, over a two-week period. This increased traffic in an already heavily traveled area, and the accumulation of mud and dust on haul roads and local roads due to the process, are all considered to be disadvantages of this method.

Mechanical Dewatering

The hydraulically dredged sediment can be dewatered by mechanical methods using belt filter presses centrifuges. In this method, the sediment is pumped from the dredge through the pipeline to the staging area and into a storage tank. The tank contains mechanical mixers, which keep the sediments in suspension in the tank. The tank acts as a buffer between dredging and dewatering since the dredge can remove sludge at a higher rate than the dewatering equipment can dewater it. From the storage tank, the sediment is pumped through a macerator and conditioned with a polymer. The polymer attaches to the solids in the sediment through an electrical/chemical bond that allows free water to separate from the solids and be pressed mechanically or centrifuged from the sediment solids. The polymers are low charge cationic polymers, which are non-toxic to aquatic organisms. Testing may be required by the regulatory agencies depending on the specific polymer that is used.

The sediment is pumped from the storage tank to the belt filter press or centrifuges. The dewatered sediment solids is discharged from a chute on each dewatering unit onto a belt conveyor, which discharges the solids into dump trailers for hauling and disposal. The dewatered sediments are approximately 22 to 25 % total solids and contain no-free water. This material will pass the paint filter test and would be suitable for hauling dump trucks or dump trailers.

A minimum of six centralized staging areas with dimensions ranging from 100 ft by 150 ft. to 100 ft by 300 ft would be required for the Muddy River. Each staging area would contain storage tanks (approximately 20,000-gallon capacity), dewatering units, sedimentation tanks, and loading areas for 18-wheel dump trucks that haul the dewatered material for disposal. Each dewatering unit would consist of a belt filter press, with a gravity or rotating thickening unit, sludge pumps, polymer conditioning system, electrical motor controls, and dewatered sludge discharge chutes. Centrifuges could also be used for dewatering. The number of dewatering units in a staging area would depend upon available space and desired dewatering rate.

Water for belt press operation and polymer dilution would be required from a City water line unless alternate provisions are made. The resultant filtrate from the dewatering process typically is settled in a basin and possibly filtered prior to returning it to the waterway. Discharge would have to meet turbidity limits. Due to the nature of the dredging and dewatering process, no work can be conducted during periods of freezing weather.

The mechanical dewatering process is advantageous because it requires the material to be a slurry, which allows it to be pumped rather than loaded onto trucks for transport. This eliminates the need to construct haul roads and loading docks, and eliminates the need for loading equipment. Pumping the material through a closed pipeline reduces exposure to the material and minimizes the accumulation of mud and dust in the work areas. The dredged material can be pumped up to one mile, which allows dewatering operation to be conducted in a few central locations. Since mechanical dewatering reduces the volume of the material by 20% to 60%, fewer trucks (approximately one 18-wheel dump truck per hour) would be needed to haul the dewatered sediment offsite to disposal facilities. This would reduce the impact that operations have on local traffic. The mechanical dewatering configuration allows for easier truck loading, making it a cleaner operation than other methods of dewatering and loading.

The uncertainty of the filtrate quality and the potential need for treatment is a disadvantage of this dewatering method.

Dredge Materials Disposal Options

There are four disposal options, one treatment option, and one in-situ disposal option for the sediment after dredging and mechanical dewatering is completed. The disposal options are dictated by the chemical contaminant levels in the sediment and include disposal at a RCRA Landfill, reuse or disposal at an out-of-state landfill, reuse or disposal at an in-state lined landfill, and reuse or disposal at an in-state unlined landfill. The treatment option consists of binding (immobilizing) certain chemical contaminants (i.e., metals) in the sediment into insoluble minerals and mixed mineral forms, rendering the sediment matrix non-hazardous.

Disposal of the sediment at RCRA landfills will be required when the chemical contaminant levels exceed RCRA characteristic and listed waste thresholds defined in 40 CFR 261 and can not be a TSCA waste as defined in 40 CFR 761.

Disposal or reuse of the sediment at out-of-state landfill will be required when the chemical contaminant levels exceed the in-state lined and unlined reuse and disposal criteria, as provided in Policy # COMM-97-001 or the physical properties of the sediment makes it unsuitable for reuse as daily cover or disposal volume is limited by market demand. However, chemical contaminant levels in the sediment can not exceed RCRA characteristic and listed waste thresholds in 40 CFR 261 and can not be a TSCA waste as defined in 40 CFR 761.

Disposal or reuse of the sediment at in-state lined and unlined landfills will be acceptable when chemical contaminant levels are below the following criteria listed in Policy # COMM-97-001:

Contaminant	***Lined Landfill(mg/kg)***	***Unlined Landfill (mg/kg)***
Total Arsenic	40	40
Total Cadmium	80	30
Total Chromium	1,000	1,000
Total Lead	2,000	1,000
Total Mercury	10	10
TPH	5,000	2,500
Total PCBs	<2	<2
Total SVOCs	100	100
Total VOCs	10	4
Conductivity	8,000 umhos/cm	4,000 umhos/cm
Listed or Characteristic Hazardous Waste	None	None

Treatment of sediment on-site by the addition of a reagent to convert leachable metals (TCLP lead identified in sediments) into insoluble minerals and mixed mineral forms would be permitted provided that DEP concurs with the use on this project. Treatment will occur either during the mechanical dewatering process or during loading into roll-off box containers. In either manner the sediment will be stored in roll-off box containers in secure areas under lock and key. Roll-off box containers would not be removed until confirmatory test results are received to confirm that the process has rendered the sediment non-hazardous. Proposed confirmatory sampling would include one sample per roll-off box composited up to 100 cubic yards. Disposal and reuse of the sediment following treatment would be at out-of-state landfill and in-state lined and unlined landfills dictated by the other chemical levels (i.e., petroleum, PCBs) in the sediment.

Prior the shipment of any sediment off-site, the following information will be received on the disposal and reuse facilities:

- General Information
  - Facility Name;
  - Facility Address;
  - Name of Contact Person;
  - Name of Emergency Contact Person;
  - Titles of Contact Persons;
  - Telephone Numbers of Contact Persons; and
  - EPA Identification Number.
- Documentation from the facilities specifying the volume of sediment that can be accepted from this project on a weekly and total basis.

Written confirmation from the facilities that they are permitted to accept and would accept the sediment of the general quality and quantity described. The Contractor's receiving facility shall also state that the facilities agree to submit to the Engineer, by fax, overnight express mail, or by courier delivery within 5 days or receipt of sediment, copies of all facility signed and receipted manifests, and completed and signed bill of lading with certified scale tare and gross weight slips for each load received. The facilities shall identify the sediment to be accepted and reference the analytical data as the basis of this classification.

Provide a listing of all permits, licenses, letters of approval, and other authorizations to operate that the facilities hold, pertaining to the receipt and management of the sediment.

The Contractor will submit the facility's complete list of permitted allowable contaminant levels and physical characteristic requirements for sediment, waste stream documentation and or profile requirements, sampling frequency requirements, and list any required regulatory approval processes that must be followed.

Prior to off-site shipment the Contractor will be responsible for preparing and submitting all waste stream profiles. The Engineer will review th profiles for accuracy and completeness and obtain the owner's signature before the profiles as sent to the facilities for approval.

Sediment that is disposed of at RCRA landfill would be transported under a hazardous waste manifest. The standard EPA 8-copy form will be utilized. The contractor will be responsible for preparing the manifests prior to the shipment date for review by the Engineer.

Sediment that is reused or disposed of at out-of-state landfills or in-state lined and unlined landfill will be transported under a DEP Bill of Lading. BWSC Forms 12A, 12B and 12C will be utilized.

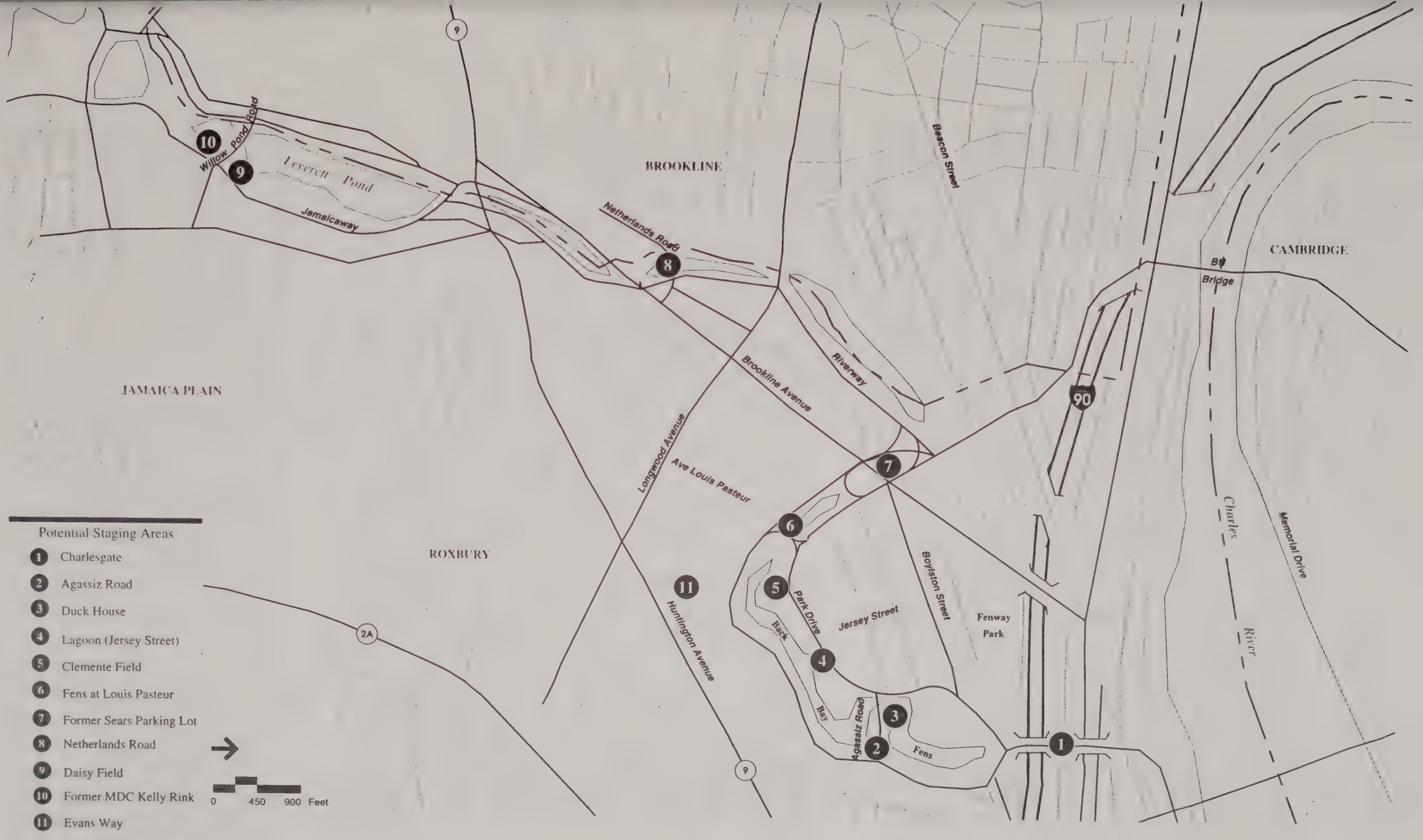
An in-situ disposal option was also considered whereby the dredged materials are disposed of in confined pits that have resulted from significant overdredging and then placing the sediments within the pits and covering the sediment with cleaner materials. In regulatory terminology, this is called Confined Aquatic Disposal (CAD). The general intent of using a CAD site is to reduce the volume of sediment that may be disposed of in deep open water areas. However, the quality of the sediment along the Muddy River limits the feasibility of CAD. RCRA sediments (approximately 45,400 cy) cannot be dredged out and then be replaced in a CAD. They must be managed accordingly as RCRA materials. There are then approximately 133,000 cy of non-RCRA sediments, that are contaminated with heavy metals, petroleum hydrocarbons and other organic compounds that also need to be dredged and managed. If one was to assume that all of the 133,000 cy was suitable for CAD disposal, the original 133,000 of contaminated sediment would have to be dredged, dewatered and temporarily stockpiled while at least110 to 120 percent more volume is further dredged to make the disposal pit. This additional material could be trucked from the site and managed accordingly. The temporarily stockpiled contaminated sediment would then be moved into the pit and capped. The additional dredging, dewatering, stockpiling and re-handling would add cost to the project. Additionally, there is no location adjacent to the project area where 133,000 cy of organic sediments could be temporarily stockpiled. The use of a CAD for the Muddy River sediment is self-defeating because one of the project goals is to remove contaminated sediment from the ecosystem.

2.1.5.2 Staging Areas and Evaluation of Locations

Eleven sites were identified as potential staging areas for dredging and construction operations. These were: Charlesgate, Agassiz Road, the Duck House, Lagoon (Jersey Street) Clemente Field, Evans Way, Fens at Louis Pasteur, former Sears parking lot, Netherlands Road, Daisy Field and the former MDC Kelly Rink. These locations are shown on Figure 2-24. The various locations were evaluated based on a set of criteria that must be considered during project planning. These criteria are: potential for bank disturbance, bridge and other height constraints, construction-related truck traffic, neighborhood traffic impacts, odors and noise impacts, park use impacts and pedestrian circulation.

The Duck House area was eliminated from consideration because it is too small an area and it has historical significance. Evans Way was not selected for dredging operations because of its proximity to residences in the Fens area and because its location would necessitate laying pipe across a major roadway. Clemente Field was not selected because it was less accessible than the Lagoon staging area, which is close enough to be used and would impact use of park recreation areas. The Sears parking lot was eliminated as a staging area for dredging operations because of a prior agreement between the City of Boston and the development company, which states that the area can only be used as parkland. The former MDC Kelly Rink was eliminated as a dredging staging site because piping would have to be put in the vicinity of an historic pool. This would create the potential to harm the pool if piping leaked.

The six sites that were selected for dredging are discussed below.



CDM Camp Dresser & McKee Inc.

Figure 2-24
Potential Staging Areas

Charlesgate Staging Area

The Charlesgate staging area that is shown in Figure 2-25 is located under the Bowker Overpass adjacent to the eastbound Commonwealth Avenue between Charlesgate East and West. An extension of this staging area could be placed on the north side of Commonwealth as shown on Figure 2-25. The riverbank in the vicinity of the Charlesgate staging area is an engineered, riprapped bank; therefore disturbance from construction activities would be minimal and can be repaired. The area is partially located under a roadway overpass. Height constraints of equipment will need to be considered during mobilization and construction activities. Trucks would access and leave the staging area on Commonwealth Avenue, which already handles a large volume of commercial traffic. The neighborhood traffic would be increased by 30 vehicle trips over a seven hour work day. The roadways in this area carry over 11,000 vehicles per day (see Section 4). Since the staging area is located between several roads in the Back Bay, the ecological, historic resource and habitat impacts are minimal or non-existent. The proposed staging area currently contains some park benches and pedestrian paths that receive little use, therefore restricting access to the area during operations would not have a significant impact on public use.

Agassiz Road Staging Area

As shown in Figure 2-26, The Agassiz Road staging area is located at the easterly end of Agassiz Road at The Fenway. Portions of the roadway and adjacent park area would be used as the staging area. This staging area will not increase bank disturbance because equipment will access the river in an area where bank reconstruction is planned because of the significant *Phragmites* removal that will be performed. Equipment and trucks would access the area from the roadway where there are no overhead constraints. Construction related trucks would enter the staging area from Park Drive and exit onto The Fenway. The increased truck traffic would be 30 vehicles per day. Park Drive in this area carries approximately 1,500 vehicles per day and the Fenway approximately 8,000 (see Section 4). Local traffic patterns will be disrupted due to the closing of Agassiz Road, which has a vehicle volume of 1,400 vehicles per day. The staging area is located on the roadway; therefore the ecological, historic resource and habitat impacts would be minimal. Odor and noise impacts would be minimal because the area would not be accessible to the public during operations and it is not near residential neighborhoods. Park use and pedestrian traffic will be impacted because the benches and paths along the roadway and in the vicinity of the Duck House will not be accessible during operations.

Lagoon (Jersey Street) Staging Area

The Lagoon staging area (see Figure 2-27) is between the lagoon area of the Muddy River and Park Drive. Riverbank disturbance would be increased where the equipment accesses the river from this staging area. The area is a large open park and there are no overhead constraints. Trucks will enter and exit the staging area from Park Drive. Operations at the staging area will add 30 vehicle trips per day to the 1,400 vehicles that currently travel Park Drive daily (see Section 4). The staging area would not create neighborhood traffic impacts because it would not require that

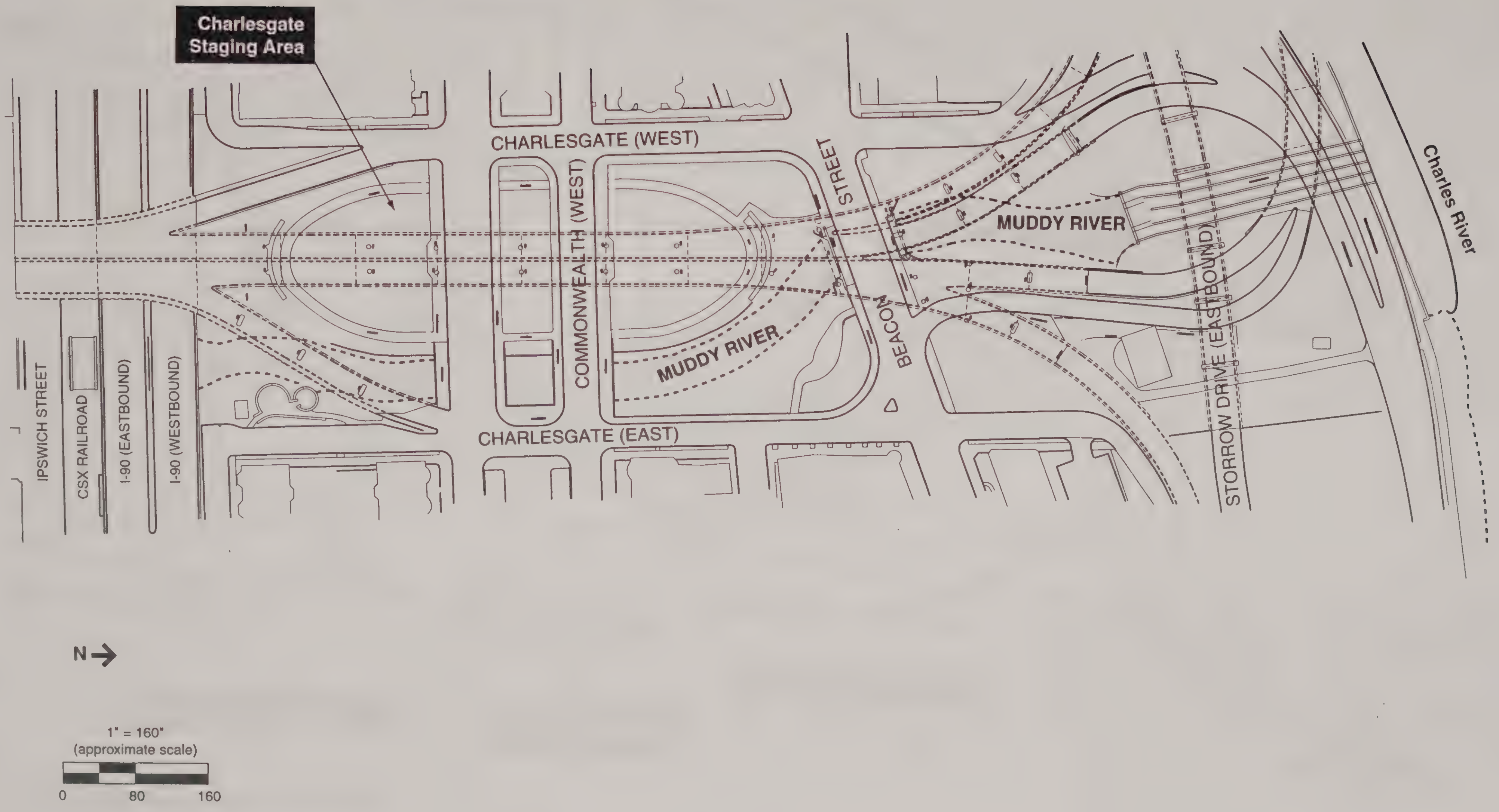


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Figure 2-25
Charlesgate Area

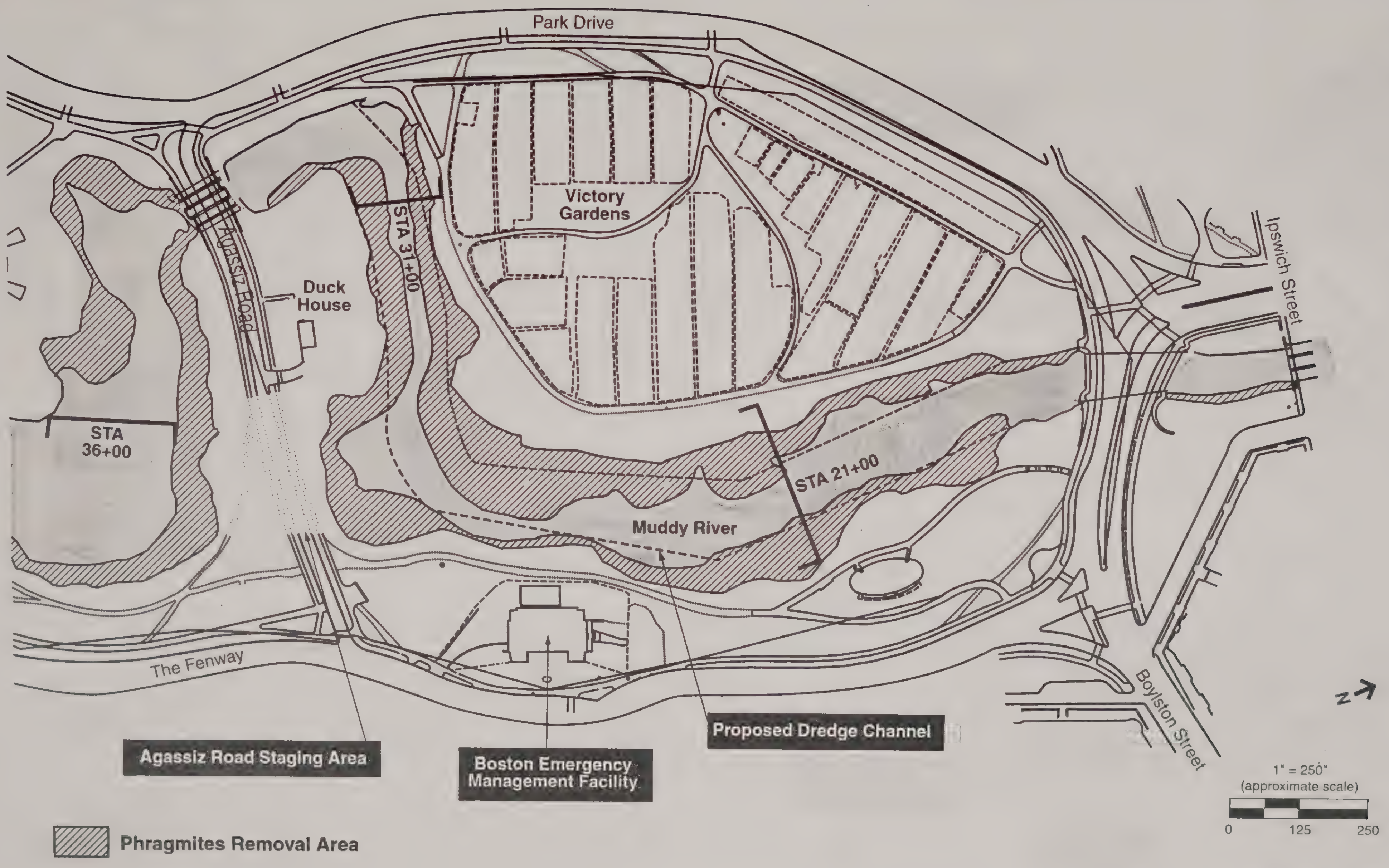

Figure 2-26
Lower Fens North Basin & Agassiz Road Staging Area and Cross Section Locations

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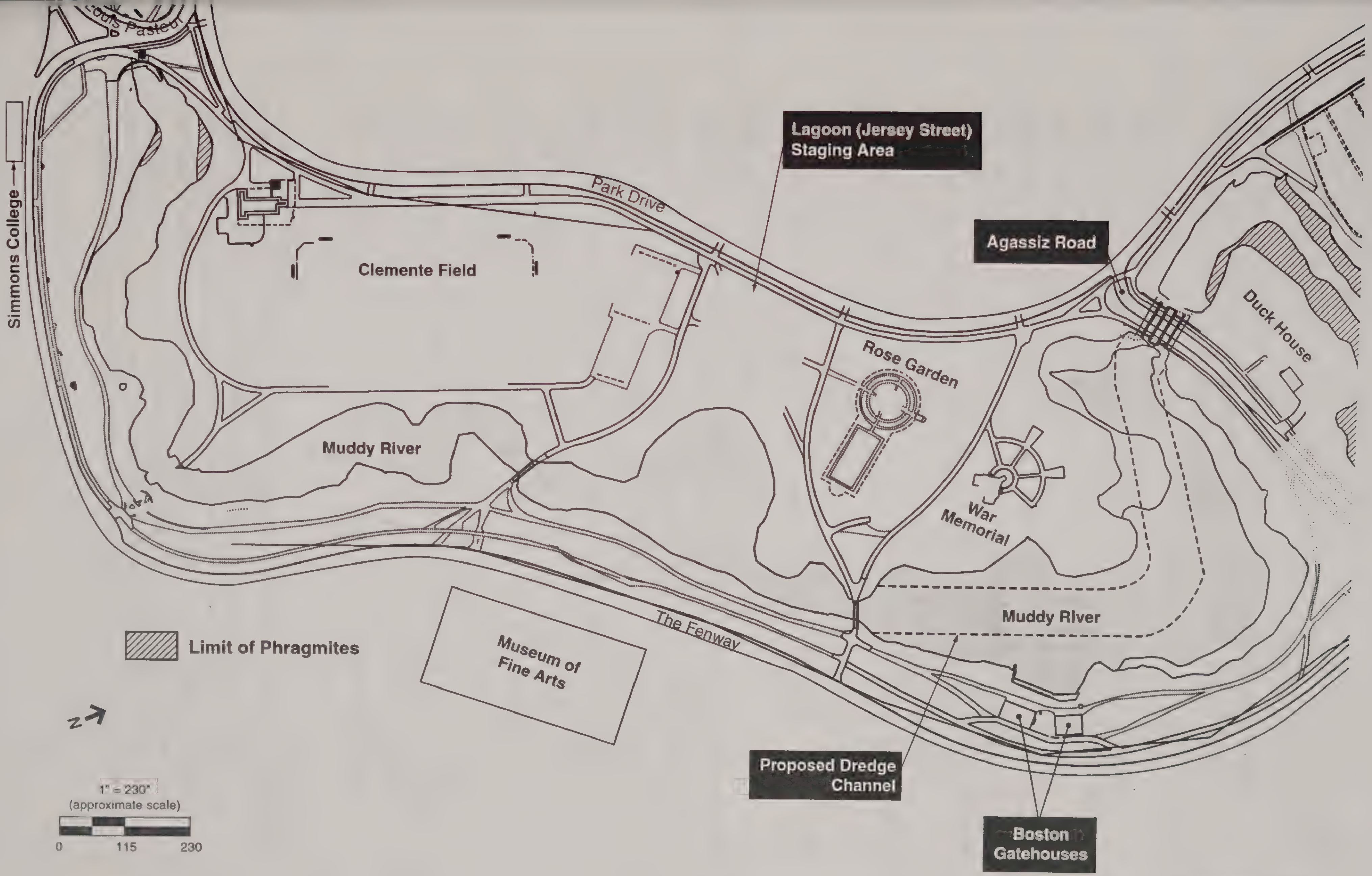

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Figure 2-27
Lower Fens Southern Basin & Lagoon (Jersey Street) Staging Area

roads are closed or traffic re-routed. Park use and pedestrian circulation will be impacted by the location of this staging area. Odor and noise impacts from operations could affect park use in the vicinity.

Fens at Louis Pasteur Staging Area

The Louis Pasteur staging area is located on the filled area upstream of the Fens Bridge (see Figure 2-28) . Equipment entering Upper Fens Pond from this staging area would not increase bank disturbance because this area would undergo construction to relieve flow constriction in existing culverts after dredging is completed. There are some trees that will create height constraints in some parts of the staging area. Truck traffic will increase during operations by 30 vehicle trips per day, which will impact traffic. This area is heavily traveled, with 9,000 vehicles using the U-turn at Avenue Louis Pasteur daily (see Section 4). Neighborhood traffic patterns would not be impacted by operations because roadways would not be closed. The staging area surrounded on three sides by roadways in an urban area and therefore does not present any ecological, historic resource or habitat concerns. Residences in the area are close enough to be affected by odor and noise impacts. Park use and pedestrian circulation impacts would be minimal because the perimeter of the area would be accessible during operations for pedestrian traffic.

Netherlands Road Staging Area

The Netherlands Road staging area is shown on Figure 2-29 and located at the eastern end of Netherlands Road at the Riverway. The roadway and adjacent park land form the staging area Equipment access to the river from this staging area would be in a location where *Phragmites* is being removed; therefore the riverbank disturbance would not be increased. There are no overhead height constraints in the area. Truck traffic to the surrounding roads will be increased by 30 vehicle trips per day during operations and neighborhood traffic will be impacted because Netherlands Road would be closed. The eastbound side of this road carries 2,600 vehicles per day and the westbound carriers 3,500 vehicles per day (see Section 4). The staging area is located primarily on the roadway and would not have any ecological, historic resource of habitat impacts. Odor and noise impacts may affect local businesses nearby in Brookline. The staging area is adjacent to the parkland surrounding The Riverway and the landscaped island upstream of Netherlands Road but it would l only affect park use in the immediate vicinity. Pedestrian circulation will not be impacted except that the Netherlands Road bridge will not be accessible during operations.

Daisy Field Staging Area

As shown in Figure 2-30, the Daisy Field staging area is located on the softball field at the southern end of Leverett Pond. The bank near this staging area would be disturbed by equipment accessing Leverett Pond, in an area where existing erosion problems already have created a need for bank reconstruction. There are no bridge or height constraints. Truck traffic would enter the staging area from Willow Pond Road, which currently carries approximately 7,500 vehicles per day during the week (see Section 4). Operations would increase this number by 30 vehicle trips per day.

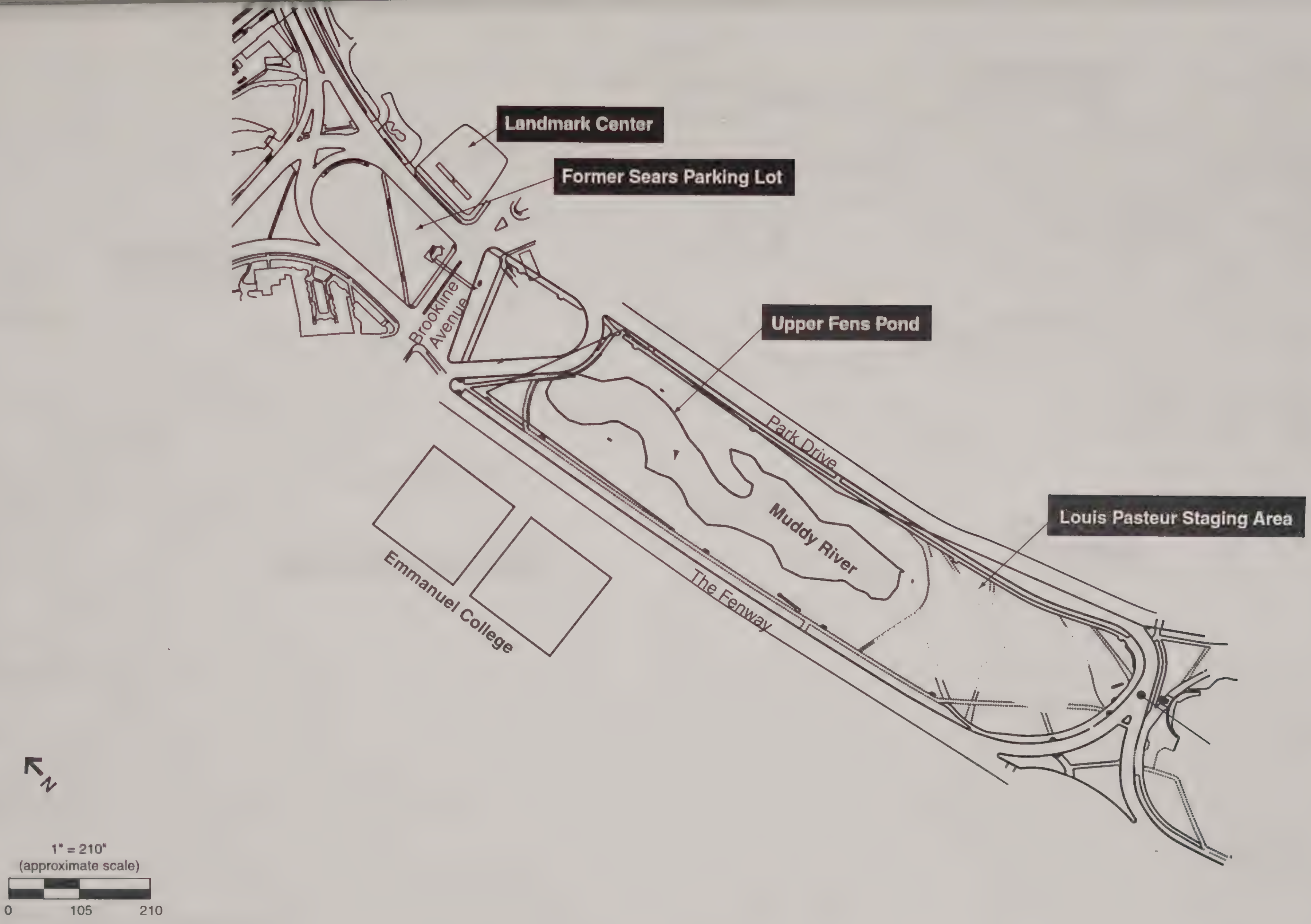

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Figure 2-28
Upper Fens Pond & Louis Pasteur Staging Area

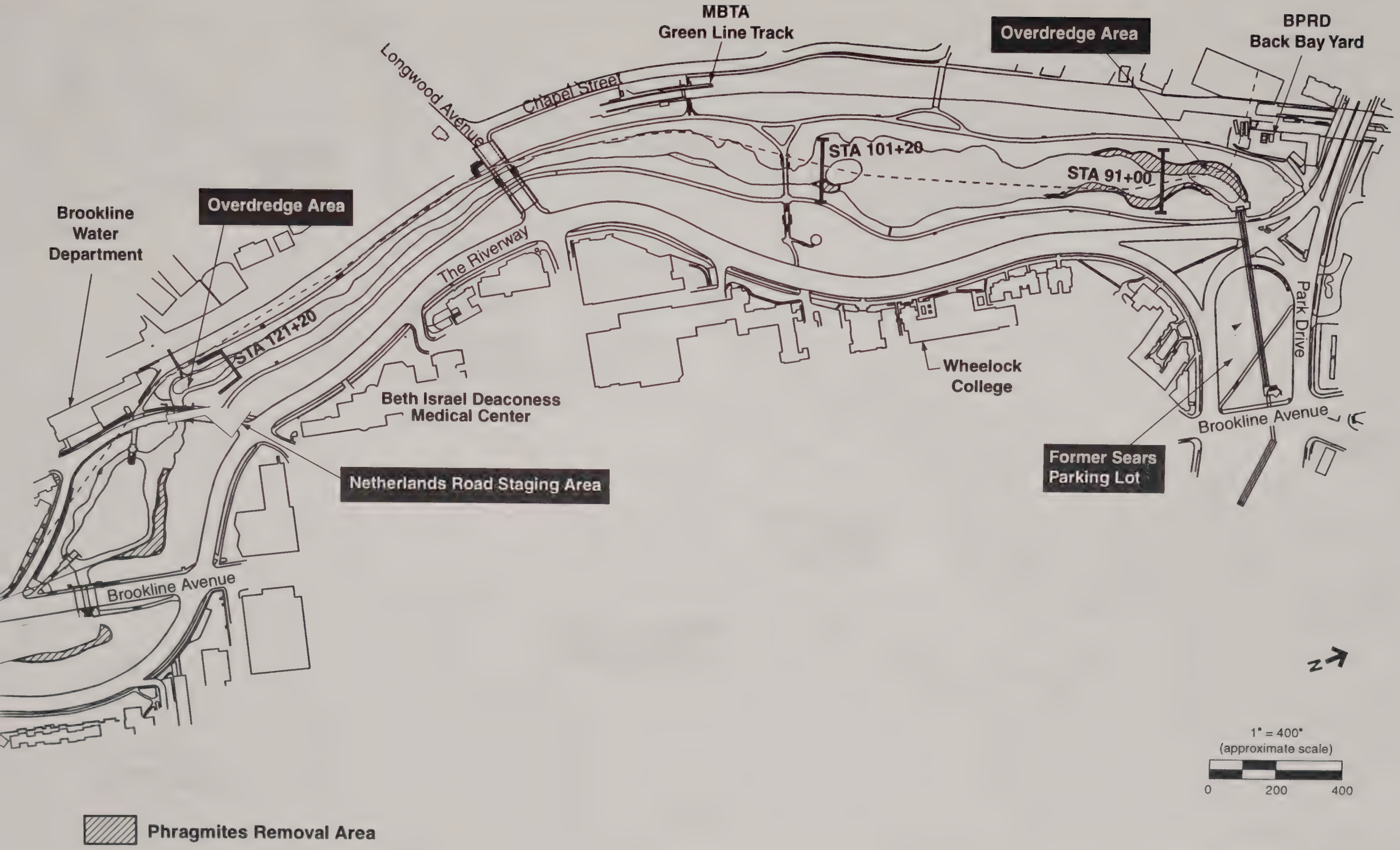

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Figure 2-29
Riverway North & Netherlands Road Staging Area

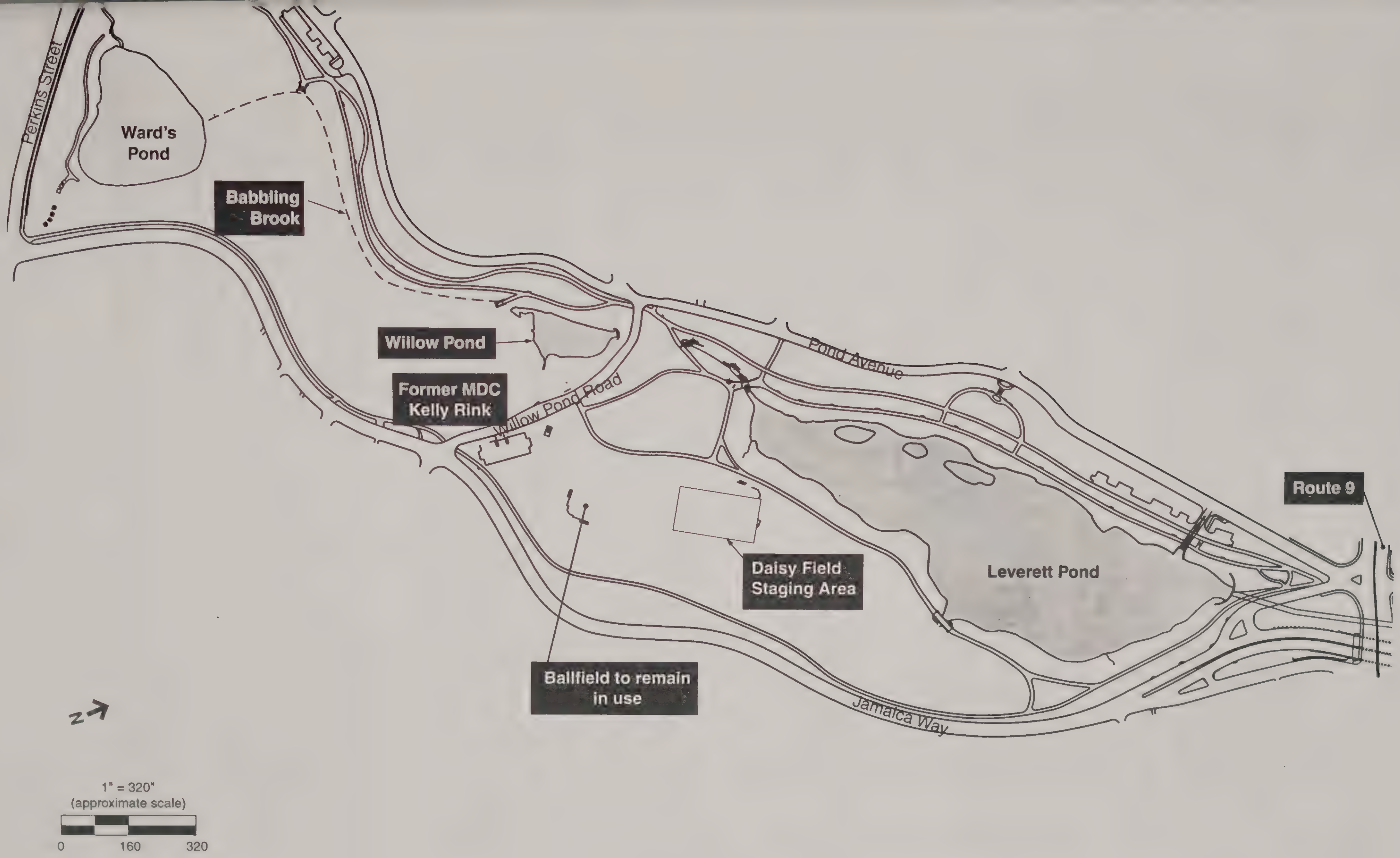


Figure 2-30
Ward's Pond, Willow Pond and Leverett Pond and Daisy Field Staging Area

CDM Camp Dresser & McKee Inc.

Neighborhood traffic patterns would not be impacted by the staging area. The area is currently an open baseball field field; therefore the staging area would not create any ecological, historic resource and habitat impacts. Odor and noise impacts will be minimal since the staging area is not in close proximity to residences or businesses. The south ballfield that is closest to Willow Pond Road would be available for use during construction and the pedestrian use of the fields would be restricted in the area near the staging area.

Several of the potential staging area locations that were eliminated from consideration for dredging could be used for other construction activities. For instance, the area across Commonwealth Avenue for the proposed Charlesgate staging area and Evans Way can be used to store equipment. The former MDC Kelly Rink location could be used to store equipment or as a truck staging location. The former Sears parking lot would become a construction area during the infrastructure improvements.

2.1.5.3 Evaluation of Partial and Full Dredging

Partial and full dredging alternatives could provide varying degrees of relief from the flooding by increasing the hydraulic capacity through the Muddy River. The following sections contain descriptions of the relative advantages and disadvantages of either partial or full dredging.

Dredging the Charlesgate Area Only

This alternative involves dredging the Charlesgate section of the Muddy River from the culvert under Storrow Drive to the Richardson Bridge and removing a stop log structure that is located under the Ipswich Street overpass. Deposited sediments and the stop log structure are severely constricting flow through this stretch of the river.

The Charlesgate portion of the Muddy River is a 1,300-ft. section that runs from the Richardson Bridge to the Charles River through a culvert under Storrow Drive. The area is highly urbanized with significant residential, commercial, institutional and transportation uses. This section of the river has an engineered bank constructed of riprap, and it flows through seven culverts under several major roadways in the Back Bay: Ipswich Street, the Massachusetts Turnpike (I-90), Commonwealth Avenue, Beacon Street and Storrow Drive.

The average width of this length of the river is 45 feet, and it widens to approximately 75 feet at the Storrow Drive culvert. The water depth ranges from 1.5 to 7 feet and the water surface elevation varies from 7.9 to 8.5 (BCB). Sediment depths range from 4 ft. to 8 ft. and samples collected from the Charlesgate area indicated the sediments meet unlined in-state landfill criteria. There were several compounds detected and, most notably, some petroleum odor, but nothing to indicate concern for disposal. Complete analytical data are presented in Appendix F.

Under this alternative, sediment in the Charlesgate area would be dredged using hydraulic dredging methods. A portable, barge mounted dredge would be used in the open channel sections, and mechanical dredging methods or pumps would be used to remove sediment under the low overpasses to parts of the channel that are inaccessible to the barge. The dredge would pump the material to the Charlesgate staging area from the barge through a pipeline that is attached to the dredge. The pipeline can be floated in the river to avoid disrupting vehicular and pedestrian traffic that otherwise could be impacted as the result of placing it on the roadways. Dredging methods are discussed in detail in Section 2.1.5.1.

The entire width of the open channel would be dredged to el.1.03 BCB in the Charlesgate area. The current elevation of the top of the sediment ranges from approximately el. 0.4 to el. 4.3 BCB. This would result in approximately 3,300 c.y. of material.

The proposed staging area for the Charlesgate dredging is located in the grassy area adjacent to Commonwealth Avenue (Eastbound) under the ramp connections to Storrow Drive. It would be approximately 50,000 ft^2. This area is currently a small park on MDC property with benches and walkways, and trucks can access it from Commonwealth Avenue. The Charlesgate section of the river and staging area to the south and north sides of Commonwealth Avenue are shown on Figure 2-25.

Hydraulic modeling of the Muddy River (see Section 5 and Appendix E) has shown that dredging just the Charlesgate portion of the river would not fully achieve the objective of flood control. This alternative would enhance the carrying capacity of the lower part of the river but would not address the upstream flooding problems in the Town of Brookline, the Medical District and in the MBTA Green line stations. Dredging and removing the obstructions would lower and design water level at Ipswich Street by only about 1.1 feet and this would be negligible at the former Sears parking lot. Dredging of the Charlesgate area would be required to accommodate increased flows if upstream dredging is performed or improvements to the culverts in the former Sears parking lot are made.

Dredge Channel through Back Bay Fens

The partial dredging alternative involves dredging a 30 foot wide (at the bottom) trapezoidal channel with 4 horizontal to 1 vertical side slopes with a bottom elevation that slopes from 2.03 to 1.03 (BCB) datum from downstream of the Brookline Gatehouse at Brookline Avenue to Ipswich Street. This alternative includes *Phragmites* stalk and root mat removal where *Phragmites* infringe on the channel.

The section of the river from just downstream of Brookline Avenue, at the former Sears parking lot to Ipswich Street, is approximately 6,600 feet long and is divided into three sections: the Upper Fens Pond from Brookline Avenue to Avenue Louis Pasteur, the Lower Fens Southern Basin from Avenue Louis Pasteur to Agassiz Road and the Lower Fens Northern Basin from Agassiz Road to Ipswich Street.

Upper Fens Pond watercourse is approximately 615 feet long. Water discharges to the pond from the Brookline Avenue gatehouse through a 7 ft x 9 ft drain that runs under the turning loop (jug handle) at the Brookline Avenue/Park Drive intersection and converts to two 72 inch culverts. The inverts of the culverts are below the water surface and are not visible. These culverts would be replaced as discussed in Section 2.1.2.2. At the downstream end, the Upper Fens Pond discharges to two submerged 72 inch culverts under the adjacent grassy area. These culverts connect to a 16.5-ft wide arch culvert under Avenue Louis Pasteur, which discharges to the Lower Fens. The 72 inch culverts would be removed and replaced with an open channel as part of this project. Park Drive runs along the north edge of the river and The Fenway is located to the south. Both roads handle heavy vehicular traffic. The Upper Fens Pond and Louis Pasteur staging areas are shown on Figure 2-26

The Lower Fens Southern Basin watercourse is a meandering 3,300-foot section of the river that is surrounded by parkland. Clemente field, the Rose Garden and the war memorial are located along this section of the river and the Museum of Fine Arts is located across The Fenway just south of the river. The park area surrounding the river receives a lot of recreational use. There are numerous pedestrian paths in the area and two footbridges traverse the river near Clemente Field and the Rose Garden.

The river flows into the Lower Fens Southern Basin from the two 72 inch culverts through an arched culvert under Avenue Louis Pasteur (Fens Bridge). It flows through the basin, passing under two footbridges, and discharges to the north basin through the multi-arched bridge under Agassiz Road. Boston Gatehouse No. 1 and No. 2 are located on the eastern bank of the river. During periods of high flow, water from the Stony Brook Conduit, which drains a 13 square mile urban area can enter the Muddy River through Boston Gatehouse No. 1. Lower Fens Southern Basin and the proposed dredge channel location are shown on Figure 2-27.

The Lower Fens North Basin watercourse is approximately 2,140 ft. long and flows from Agassiz Road to Ipswich Street. The historic Duckhouse is located at Agassiz Road. The Fens Victory Gardens line the western side of the river along this stretch and the fire station and a playground and park area are present along the eastern side. The surrounding area is also highly urbanized with a lot of vehicular and pedestrian traffic. Park Drive runs along the western edge of the Victory Gardens, The Fenway and the Westmoreland Gate are located along the eastern edge, and the river passes through a large, arched bridge at Boylston Street (Richardson Bridge) prior to reaching Ipswich Street and the Massachusetts Turnpike (I-90). This section of the river is shown on Figure 2-26.

The variation in the width of the river is greatest through the Back Bay Fens area. The width of the Upper Fens Pond is fairly consistent at approximately 65 feet wide for most of the upstream end and increasing to a maximum of 95 feet wide before entering the downstream culverts. The Lower Fens Southern Basin ranges from approximately 50 feet wide to 120 feet wide as it travels around Clemente Field, and then widens into a pool approximately 260 feet wide (the "Lagoon") as it approaches the Rose Garden. Downstream from the Rose Garden the river widens to an average width of 200-220 feet from bank to bank before narrowing by Agassiz Road. There is some *Phragmites* growth at the upstream end of the south basin, which increases in the stretch just upstream from Agassiz Road. Downstream of Agassiz Road the river varies in width from 85 to 200 feet wide from bank to bank. Significant Phragmites growth along this stretch has reduced the water channel to a width of 25 feet near the Duckhouse.

The water depth in the Upper Fens Pond is approximately 0.5 to 2 feet (est.), and the water surface elevation is approximately 8.0 to 8.5 BCB. The sediment in this part of the river ranges from 2 to 7 ft deep. The water depth in the Lower Fens Southern Basin varies from 0.5 to 5.5 ft and the water surface elevation is approximately 8.0 to 8.5 BCB. The sediment thickness ranges from nonexistent in some areas to 12 ft. The Northern Basin water depth ranges from 2 to 6.5 ft., and the water surface elevation varies from 8.0 to 8.5 BCB. The sediment depth is between 2 and 12 ft. Sediment quality in the Back Bay Fen is the poorest of any section studied. Arsenic and lead exceeded lined landfill criteria and leachable lead exceeded regulatory criteria at several locations. About 10 percent of the samples exceeded PCB and reactive sulfide criteria. There also were a few exceedances of the lined landfill criteria for polynuclear aromatic hydrocarbons.

The proposed channel would be dredged using hydraulic dredging methods as described in Section 2.1.5.1. *Phragmites* would be removed by mechanical methods from the water by using a barge-mounted excavator or low-impact excavator that could be supported on the root mat.

The bottom of the channel through the Fens area would be 30 feet wide and would be dredged to between 2.03 and 1.03 BCB with 4 horizontal to 1 vertical side slopes. In some areas, such as the upper Fens pond and near Clemente Field, this would result in bank to bank dredging of the watercourse. The current top of sediment elevation in the entire Fens area ranges from approximately 3.0 to 7.0 BCB. Dredging the channel would result in approximately 30,780 c.y. of sediment and 8,230 cy of *Phragmites* removal.

Under this alternative, the dredged sediment would be pumped to one of three staging areas in the Fens for dewatering. Material from the Upper Fens Pond and approximately 1,600-ft of the Lower Fens Southern Basin would be processed at the Fens at Louis Pasteur staging area. This staging area would be approximately 285 ft. by 150 ft. large and would be located in the grassy area downstream of and adjacent to the Upper Fens Pond. Sediment and *Phragmites* from the remaining portion of the southern basin (approximately 1,300-ft. of river to Agassiz Road bridge) would be processed at the Lagoon (Jersey Street) staging area that would be located on parkland that is located between Clemente Field and the Rose Garden. The staging area is approximately 52,000 ft^2. It is an open, grassy area of parkland with several pedestrian paths running through it and around the perimeter. The sediment and *Phragmites* that would be removed from the Fens North Basin would be processed at the Agassiz Road staging area. Agassiz Road would be closed during operations and the staging area would be set up on the east end of the roadway. The staging area would be approximately 31,000 ft^2 and would be located on the roadway and the grassy area along both sides of the road. This area is open and grassy with a few trees. Selection of staging areas is discussed in Section 2.1.5.2.

Typical cross-sections of partial dredging in the Back Bay are shown in Figure 2-31, and the locations of the cross-sections are shown on Figure 2-26. Dredging the channel would create an average cross section of approximately 364 square feet.

Hydraulic modeling has shown that the channel alone, through the Back Bay Fens, would partially achieve the objective of flood control by increasing the cross-sectional area of flow in the Back Bay Fens and by providing additional storage downstream of the Riverway.

The channel dredge alternative using the 30-foot bottom dimension is the minimum channel necessary to carry design storm flows if the upstream improvements are made. If the channel were not dredged to this width, upstream improvements would release more flow to the Back Bay Fens area and increase flooding.

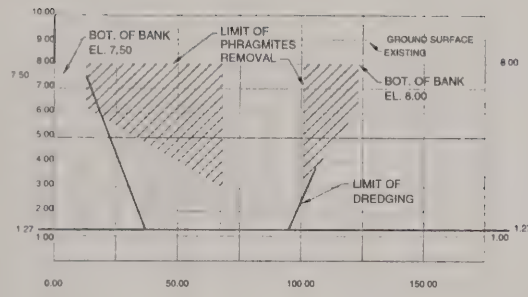
Dredging of The Riverway

Sections of the Riverway are grown over with *Phragmites* such that the main flow channel in The Island Area at Netherlands Road is completely blocked and other channel areas closer to the twin 72" culverts under the former Sears parking lot have become severely constricted. The hydraulic modeling(see Appendix E) shows that the removal of *Phragmites* from these areas is necessary in order to provide adequate flow of flood water. Therefore, under this sub-alternative, the area in The Riverway that are blocked or constricted with sediment and/or *Phragmites* would be dredged to provide the necessary flood relief. The advantages and disadvantages of partial or full dredging of the Riverway are discusses further in Section 4 and 6 and Appendix E.

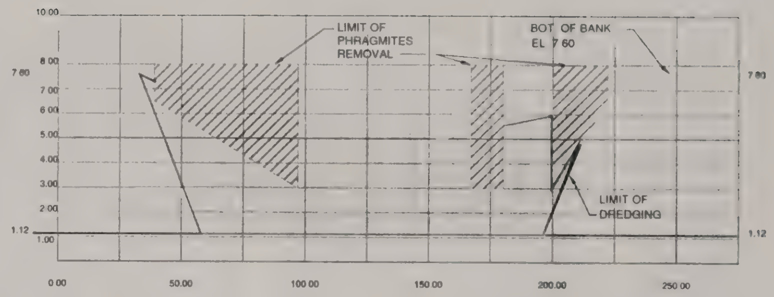
Bank-to-Bank Dredging

Bank-to-bank dredging was evaluated as an alternative to meet the flood control objective. It is also evaluated as an alternative to meet other project objectives. (See subsection 2.2.9 for bank-to-bank dredging to improve water quality and subsection 2.3.3 for bank-to-bank dredging to enhance aquatic and riparian habitat.)

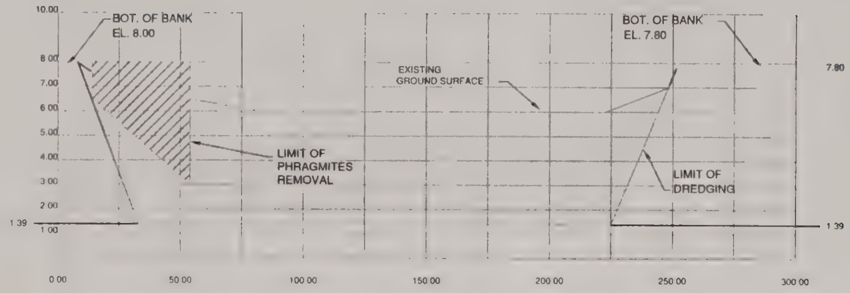
The need for this alternative was examined in the Back Bay Fens and The Riverway. The bank-to-bank dredging alternative would, as the term implies, involve dredging all materials from one side of the river to the other including sediment and *Phragmites.* Hydraulic modeling in the Fens indicates that the 30-foot channel previously described is the minimum necessary to carry the design flood flows. For the objective of flood control taken alone, bank-to-bank dredging may not be necessary. However, considering the aggressive growth of *Phragmites* that restrict flow at several points along the river in the Fens and the Riverway, the continued maintenance of the necessary flood channel would depend on the additional dredging required for the complete removal of the *Phragmites*. Also, when the other project objectives are also



DREDGE CROSS SECTION
AT STATION 31+00



DREDGE CROSS SECTION
AT STATION 21+00



DREDGE CROSS SECTION
AT STATION 39+00

- BOSTON CITY BASE DATUM (BCB)
- LOCATION OF CROSS-SECTIONS SHOWN ON FIGURE NO. 5-3

Figure 2-31
Cross Sections of Back Bay Fens

considered, bank-to-bank dredging does provide positive impacts on water quality, riparian and aquatic habitat, as well as historic rehabilitation. See further discussions of this alternative in subsections 2.2.9, 2.3.3 and 2.6.

2.1.5.4 Screening of Flood Control Alternatives

The screening of the alternatives that were examined for satisfying the needs of the Flood Control Objectives are shown in Figure 2-32.

Of the six alternatives considered to fulfill the project of flood control, the No Action Alternative and Flood-Proofing of Property alternative have been eliminated because they do not achieve the project objective. Creating sufficient upstream storage to alleviate downstream flooding was eliminated because it is technically in feasible.

The remaining alternatives of dredging only the Charlesgate Area, partially dredging the Back Bay Fens and remove flow constrictions in the culverts (infrastructure improvements) were retained because each of them partially fulfills the flood control objective. Hydraulic modeling of the muddy River indicates that only a combination of these three alternatives would fully achieve the project objective of flood control to reduce the level of flooding upstream of The Riverway at the former Sears parking lot to less than elevation 15 BCB.

The infrastructure improvement alternatives between The Riverway and Avenue de Lois Pasteur include increasing flow capacity through a combination of daylighting, culvert capacity enhancement, or culvert replacement. There are several ways to achieve the increase in capacity, and the sub-alternatives for infrastructure improvements are described in Section 2.1.2. All of the sub-alternatives meet the basic hydraulic capacity requirements for the design storm. The differences between sub-alternatives are principally in the configuration of facilities, costs, and the ability of the sub-alternatives to address other project alternatives such as historic and landscape issues. Selection between sub-alternatives is discussed in Section 2.6.
An alternative for full dredging of the Muddy River and the upstream pond is included in section 2.3. Full dredging means dredging the full channel width from bank to bank. Full dredging is the alternative based on its ability to achieve flood control and the additional environmental benefits of improving water quality, improving aquatic and riparian habitat and restoring historic and cultural resources. The hydraulic modeling indicated that bank-to-bank dredging of the Riverway is not necessary for flood control purposes. However, the hydraulic modeling also shows that an increase in the flow velocity of floodwaters through The Riverway as well as in other river segments would result from the implementation of the downstream channel dredging and infrastructure improvement alternatives.

After considering the alternative dredging and dewatering methodologies, the environmental impact, and the ability of an alternative to meet the project objectives, hydraulic dredging and mechanical dewatering using belt presses or centrifuges is recommended for sediment dredging. Hydraulic dredging is expected to have less

	Provide Flood Control	Improve Water Quality	Enhance Aquatic/Riparian Habitat	Treat Landscape/Historic Resources	Institute BMPs
No Action					
Infrastructure Improvements					
Engineered Channel / Culvert Enlargement	□				
Historic Alignment / Culvert Enlargement	□				□
Modified Alignment / Culvert Enlargement	□				□
Dredge Charlesgate Only	□	□	□		
Dredge Channel Through Back Bay Fens	□	□	□		
Flood Proofing of Property					
Increase Upstream Storage					

△	*Fully meets objective*
□	*Partially meets objective*
○	*Addresses some elements of objective*
BLANK	*Does not address objective*

Figure 2-32
Screening of Flood Control Alternatives

environmental impact on the surrounding park area and also produces lower turbidity in the river than mechanical dredging methods. This does not exclude the use of mechanical dredging via excavators in selected portions of the Back Bay Fens near the Fens Bridge or the Riverway where the removal of Phragmites and sediment cannot be conducted via barge equipment and/or hydraulic dredging due to unacceptable environmental impact. Mechanical dewatering is recommended to eliminate double handling of sediments and control exposure of odors and dust to the environment. Mechanical dewatering can be implemented in the park setting unlike air drying that would take significant area and potentially expose residents to odors and dust for long periods during drying.

2.2 Improvement of Water Quality

The benefits of addressing each of the objectives of the Muddy River Project are so inter-related that one cannot necessarily be accomplished without another having been conducted. For example, flood improvements are directly related to dredging which relates to enhanced aquatic habitat with also relates to enhanced water quality conditions, etc. Nonetheless, the improvement of water quality is one of the key objectives of the Muddy River Project with a goal of contributing to meeting the Class B Water Quality Standards of swimmability and fishability.

The historic water quality record indicates contamination with very high levels of fecal bacteria, chronically low dissolved oxygen concentrations, excessive nutrients and suspended solids. The existing sediment quality data also indicate that lead and petroleum hydrocarbons were contained in runoff entering the Muddy River and that DDT was also contributed from sources within the watershed.

The findings of the water quality monitoring that was conducted as part of this EIR (see Appendix G - Water Quality) indicate that during wet weather, high levels of bacteria and nutrients continue to be contributed to the Muddy River from the storm drainage system. Of the storm drainage outfalls that were sampled in the fall and early winter of 2000, the Longwood Avenue Drain, Tannery Brook Drain, the Daisy Field Drain and the Chestnut Street Drain need further investigations into the sources of bacteria, nutrients (nitrogen and phosphorus), as well as suspended solids. The Daisy Field Drain in particular, contains very high nutrient concentrations which should be investigated.

Measures to improve the quality of water in the Muddy River have been underway for almost three decades. This work includes water quality monitoring that was conducted by the Division of Water Pollution Control, the predecessor of the Massachusetts Department of Environmental Protection in 1974; as well as more recent monitoring that was conducted by the US Army Corps of Engineers (ACOE) in 1992 and 1995; the Charles River Watershed Association in 1998; very recent monitoring that was conducted as part of this Muddy River Phase I Project in 2000; and corrective measures that have been implemented by the City of Boston and the Town of Brookline. Since the 1980s the BWSC has been implementing numerous programs to improve water quality. These included: the compliance with the EPA's

National Pollutant Elimination System (NPDES) Permit for the BWSC (1999); implementation of a Stormwater Management Program under which there is a program to eliminate illegal sewer connections to storm drains, the control of sanitary and industrial discharges and combined sewer overflows (CSOs), operation and maintenance of stormwater control structures, control of discharges from development and construction sites; public education including catch basin stenciling, a web site, and the support of watershed and environmental agencies and organizations. The BWSC has also recently undertaken a program to clean years of accumulated sediment and to repair control structures along the Stony Brook drainage system and associated conduits. It has also begun a comprehensive program to map and develop a catch basin management program - the Boston Catch Basin Improvement Project.

In 1995 the Town of Brookline entered into a Consent Agreement with the US Environmental Protection Agency to investigate and correct illegal connections between the sanitary sewers and the Town's storm drainage system. Since the 1980's, the City of Boston began corrective measures on its storm drainage and sanitary sewer systems, through the BWSC. These measures have resulted in substantial reductions in the number of illegal cross connections. Corrective work is continuing with sewer separation construction being conducted through the fall of 2000. Some corrective measures remain to be undertaken regarding inter-municipal connections from Boston storm drains that discharge into Brookline storm drains. There remain two uncorrected illegal sewer connections to Boston storm drains in the Tannery Brook discharge system.

The purpose of this section of the EIR is to provide information on additional alternative measures that can be taken to continue the improvement of water quality.

2.2.1 No Action

Under the No Action alternative, there are extensive sewer and storm drain improvement programs that would continue in Boston and Brookline which directly or indirectly affect the quality of water in the Muddy River. Programs that will continue under this No Action alternative ongoing work by the BWSC and Brookline for sewer separation, the continuation of the Stony Brook Conduit Cleaning Project, the implementation of the Boston Catch Basin Maintenance Project, continuing the prevention, prevention, and elimination of illegal cross connections, stormwater management and monitoring programs, infiltration/inflow controls, catch basin stenciling, public education programs, , permitting of large sewer users and regulation of industrial discharges, permitting of new or retrofitted building project through the BWSC's Site Plan Review procedure, and other NPDES-related compliance efforts. These programs have resulted in improvements to water quality. The City of Boston and Town of Brookline also conduct hazardous waste and used motor oil collections. The existing BMP programs such as catch basin cleaning, street sweeping, the maintenance of particle separators, and public education would continue.

However, water quality improvement alternatives that would not be implemented under a No Action alternative are the expanded Best Management Practices (BMPs) that would otherwise have been implemented in the Muddy River watershed (see Section 5.7). BMPsTherefore, other than the ongoing programs that are underway by the BWSC, the City of Boston and Town of Brookline, as described above, the No Action alternative would leave the Muddy River watershed in a state of status-quo with continuing input of high loads of bacteria, nutrients and suspended solids.

2.2.2 Elimination of Illegal Sewer Connections

The elimination of illegal sewer connections is on-going work that is being conducted by the BWSC and the Town of Brookline. In 1995 the Town of Brookline began investigations of its storm drainage system in order to determine locations of illegal cross connections and to correct those that were found. As the result of the study, 39 sources of sewage were located. This is the equivalent of 185 dwelling units. These were found in the Tannery Brook and Village Brook drainage systems. As of 2001, the BWSC has corrected 712 illegal sewer connections city-wide, of which 30 were in the Muddy River watershed, and an addition 3 which were recently found are added to a BWSC Contract. Brookline has identified and corrected 39 illegal sewer connections (equivalent to 185 dwelling units) to storm drains in the Muddy River watershed.

Water quality monitoring that was conducted in the fall and early winter of 2000 (see Appendix G - Water Quality) resulted in the finding of additional sources of bacteria, nutrients and suspended solids in the Longwood Avenue Drain, the Tannery Brook Drain, Daisy Field Drain, and the Chestnut Street Drain, all of which need further investigation. As presented in Section 5, the proposed project included a continuation of the water quality monitoring in order to further establish the data base and to be able to assess the effectiveness of the BMP measures and other corrective work.

Therefore, although it is believed that the majority of readily detectable illegal sewer connections have been eliminated, and which the water quality data document, work would continue to eliminate any other illegal connections that are found. Continuation of water quality improvements in the Muddy River watershed through the elimination of illegal sewer connections are expected to further improve water quality.

2.2.3 Sewer Separation

As of the fall of 2000, Brookline was in the process of separating the sewer systems in the Walnut Street area. Brookline's future CIP includes sewer rehabilitation work to be the next increment of spending followed by sewer separation work in Brookline Village at Washington and Harvard Streets. Brookline does not have any combined sewer overflows into the Muddy River. The BWSC is undertaking a sewer separation project in the Stony Brook watershed. The reader is referred to Section 4 for details of the Stony Brook system. The BWSC is also coordinating with Brookline on the remaining corrections of certain inter-municipal connections from Boston storm drains that discharge to Brookline storm drains.

Therefore, the alternative of separating sewer systems is continuing in Boston and Brookline and would lead to improved water quality.

2.2.4 Point Source Control

Storm drains and the Stony Brook overflow are the only known point sources in the Muddy River watershed. As discussed above in Sections 2.2.2 and 2.2.3, the Phase I Muddy River Project includes the continued monitoring for and the elimination of illegal sewer connections and the continuation of sewer separation work.

2.2.5 Implementation of Best Management Practices for Stormwater Runoff

An additional alternative that could be designed to enhance water quality is the BMP Plan that is discussed in Section 5.6. The BMP Plan includes the phasing of BMPs into the Project starting as early as 2001. As can be observed by the comprehensiveness of the BMP Plan and its phasing, all the goals of the Phase I Muddy River Project can be cross-linked to ensure the success of the project. The BMPs could reduce re-sedimentation thereby preserving the flood control benefits of dredging in addition to improving water quality.

2.2.6 Flow Augmentation

Flow augmentation in a waterway is a method that is used to supplement the existing low amount of natural flow. Low flows between storm events lead to lower dissolved oxygen. Because of the high level of urbanization in the Muddy River watershed, and the little amount of land that remains for the effective infiltration of rainwater to recharge groundwater, the base flow (the amount of water that discharges from groundwater to the River) of the Muddy River is very low.

Therefore, the amount of water that continues to flow into and through the Muddy River from the groundwater during periods between storms, or more important that which flows during dry periods, is of a low volume. This condition is a consequence of urbanization. In addition, because groundwater contributions are more naturally located in higher elevations of a watershed, the area in the Muddy Rivers watershed is limited as well to essentially the area above the Riverway section. Summer evaporative losses also combine to take a toll on the available flow of water. Evaporative losses from the unshaded river sections and ponds along the Muddy River are large. Hence, the reasons for such low flow in the River.

The flow augmentation alternative would consist of the use of water from other sources in order to enhance the volume of water that flows down the Muddy River between storms. Such alternative water sources could include:

- Potable water;
- Water from the Chestnut Hill Reservoir that would enter through the Village Brook Drain;

- Water released from the Brookline Reservoir that also would enter through the Village Brook Drain; and
- Water that would be pumped from the Charles River and release at some upstream location(s).

In its water quality modeling of the Muddy River, the ACOE conducted a sensitivity analysis to determine the appropriate volume of water that would be necessary to augment the flow of water and improve dissolved oxygen. It was determined that 30 cubic feet per second (cfs) (225 gallons per second), combined with cascade aeration, would increase dissolved oxygen in the Muddy River above the water quality standards (US Army Corps of Engineers, 1996) (see Figure 2-33).

2.2.6.1 Flow Augmentation with Potable Water

The use of potable water as an alternative water source was dismissed because this would be an inappropriate use of potable water, which is of limited supply.

2.2.6.2 Flow Augmentation with Water from the Chestnut Hill Reservoir

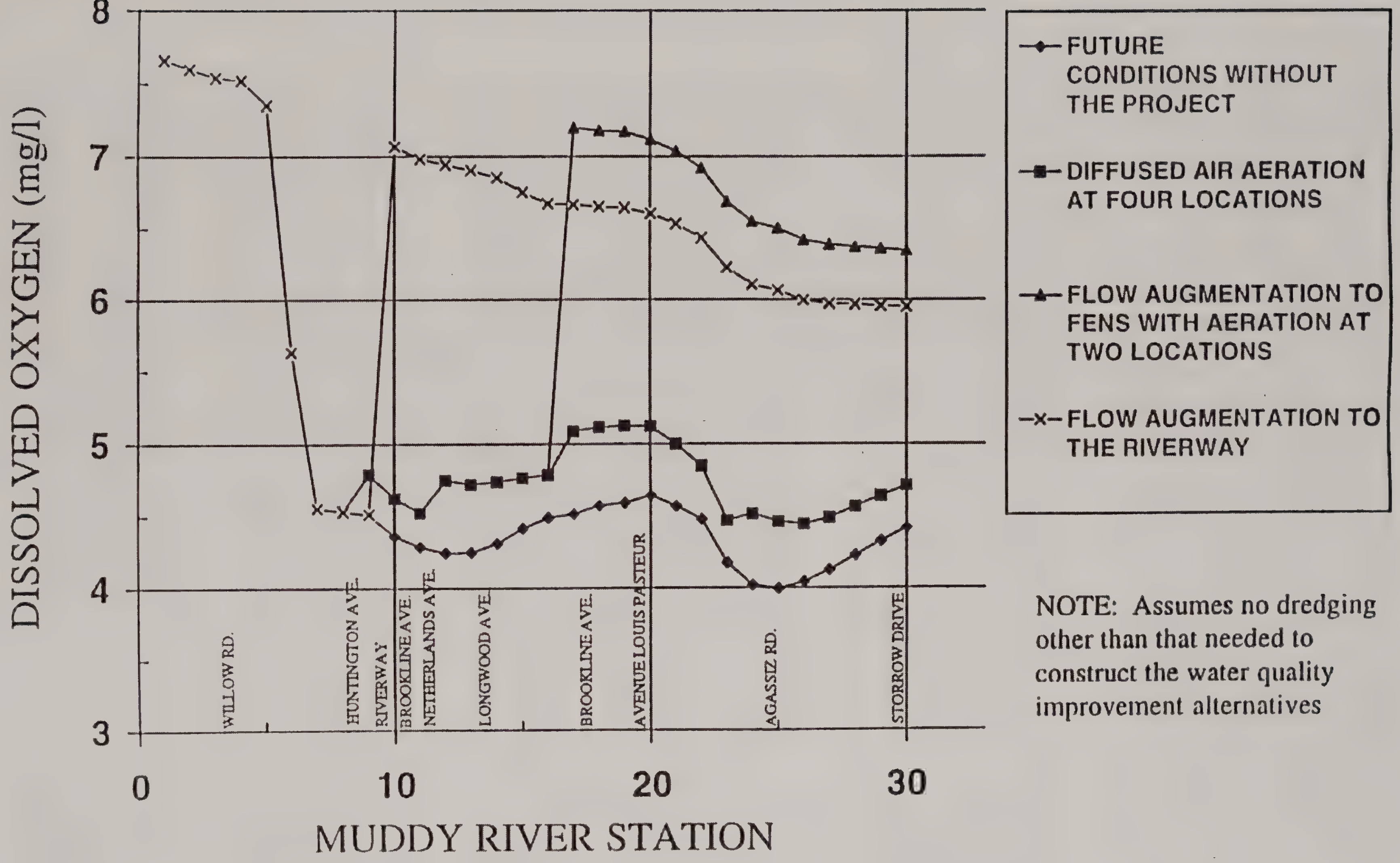
The Massachusetts Water Resources Authority (MWRA) controls the Chestnut Hill Reservoir. The use of water from the Reservoir is not considered feasible because there is insufficient water to sustain the 30 cfs flow during dry periods and this alternative could result in negative water quality impacts to the Reservoir.

2.2.6.3 Flow Augmentation with Water from the Brookline Reservoir

Water flow from the Brookline Reservoir takes place during periods of higher precipitation. Due to normal water losses through evaporation, dam leakage, and infiltration into groundwater, a surplus of water from the Brookline Reservoir does not exist during the low flow periods that it is most needed in the Muddy River. Therefore, this alternative water source was also dropped from further consideration.

2.2.6.4 Flow Augmentation with Water from the Charles River

Pumping of water from the Charles River and releasing it at upstream locations was evaluated by the ACOE during its Feasibility Study (US Army Corps of Engineers, 1996). The ACOE determined that in order for flow augmentation to effectively raise the dissolved oxygen to above the Class B standard of 5 mg/l throughout the River, the augmenting water would have to be released in The Riverway. The location just below the Route 9 bridge was modeled. A sensitivity analysis resulted in the finding that 30 cfs was the minimum effective volume. The ACOE plan was to pump 30 cfs from a pump station and intake on the Charles River, and in order to ensure that the dissolved oxygen was increased, the water would be released over a cascade aeration unit that would be constructed along River Street in Brookline. The ACOE also found that there was a higher modeled increase of dissolved oxygen when the flow augmentation was combined with dredging of Leverett Pond, The Riverway, and the Back Bay Fens.



NOTE: Assumes no dredging other than that needed to construct the water quality improvement alternatives

CDM Camp Dresser & McKee Inc.

Figure 2-33
Water Quality Improvement Alternatives
Source: ACOE, July 1996

There are two reasons why the flow augmentation with Charles River water was not carried forward in the Muddy River Project. First, based on the ACOE's water quality modeling, there would hardly be a measurable difference between the improved dissolved oxygen levels through dredging versus those resulting from the dredging combined with flow augmentation. Since dredging is necessary in order to accomplish the flood control alternative, which also results in improved water quality conditions, there is no demonstrable reason to conduct flow augmentation. Secondly, historic preservation interests dictated against the construction of a flow augmentation cascade aeration structure along the Muddy River.

2.2.7 Aeration

Aeration is the process of introducing oxygen to the water by pumping either air or oxygen through diffusers that are located in the water. The ACOE evaluated aeration during its feasibility study (US Army Corps of Engineers, 1992) and found that aeration could not increase the dissolved oxygen in the Muddy River above the Class B water quality standard unless it was combined with full bank to bank dredging and/or flow augmentation. Therefore, by itself, aeration is not an effective alternative to improve water quality because dissolved oxygen can only be increased through bank to bank dredging alone.

2.2.8 Harvesting of Aquatic Vegetation

Because aquatic plants utilize nitrogen and phosphorus from the water and sediment for their growth, the harvesting of aquatic vegetation could be used to reduce the net amount of nutrients in the Muddy River. There are, however, two drawbacks to this alternative. First, the amount of nutrients being contributed by the various storm drains along the Muddy River out-weight the amount of nutrients that could be removed by harvesting the present growth of aquatic vegetation, which is only at a moderate density at best. It would be more effective to take corrective actions to reduce the input of nutrients. Second, in order to harvest the aquatic vegetation, there would have to be adequate water depth to float and maneuver the harvesting equipment. Such water depth does not exist at present.

Aquatic plants also can be used to reduce the amounts of nutrients and certain metals in sediments, such as lead, in some of the sediments of the Muddy River. This method of reducing metals is not feasible because the amount and extent of vegetation that is necessary to provide the needed contact time and filtration that is necessary to remove the nutrients and metals from the ecosystem is so extensive that it would compromise the flood control objective by having to construct wetlands through which the water flows.

2.2.9 Dredging and Improvement of Sediment Quality

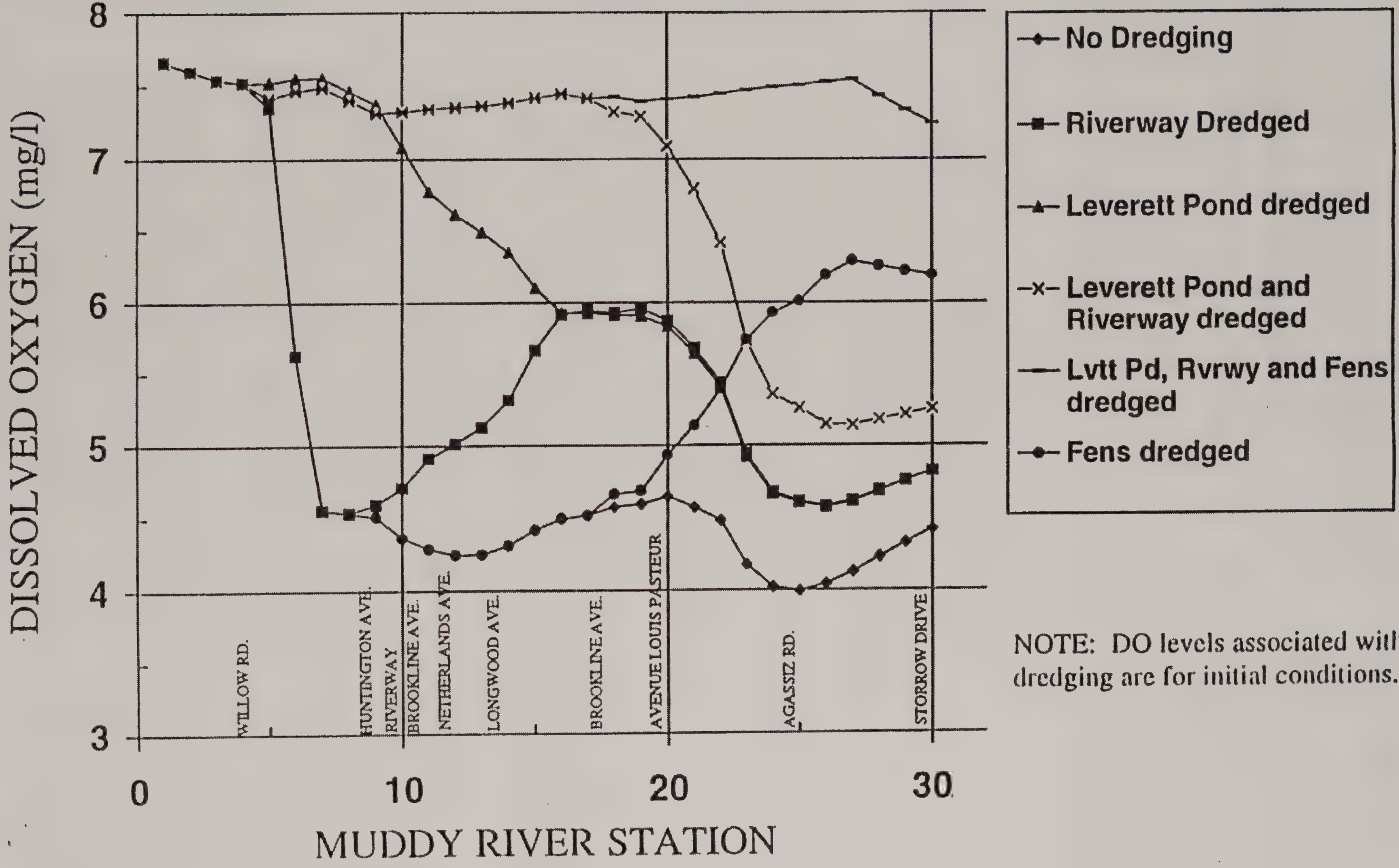
The alternative of improving water quality through the dredging of sediments is the most dramatic of the water quality improvement alternatives. Studies on the quality of the Muddy River's sediments by the US Geological Survey 1998, the ACOE (1992 and 2000) and this Phase I Project, have resulted in the finding that the sediments are contaminated with petroleum hydrocarbon compounds, heavy metals, polychlorinated biphenyls (PCBs) and chlorinated insecticides (DDT, DDD). Also there are some locations where the lead concentrations exceed regulatory thresholds and render the sediments hazardous. The ACOE also sponsored sediment studies on sediment oxygen demand (SOD) and sediment nutrient cycling (Northeastern University, December 1995). The Northeastern University findings indicated that there were locations in the River's sediment where the SOD was capable of impacting the dissolved oxygen content of the River.

The ACOE conducted water quality modeling of the Muddy River to determine the extent to which water quality, as measured by dissolved oxygen, would be improved by dredging (US Army Corps of Engineers, 1992). The modeling included bank to bank dredging with the removal of *Phragmites*. The results showed that dissolved oxygen would increase to above the water quality criteria of 5.0 mg/l throughout the River, if the dredging included Leverett Pond, The Riverway, and the Back Bay Fens (see Figure 2- 34). The modeling also showed that there would not be an improvement of dissolved oxygen if only individual segments of the Muddy River were to be dredged (say the Back Bay Fens only).

The proposed project includes the removal of most of the anthropogenic (culturally related) sediments throughout the river system. The removal of sediment in the Back Bay Fens is the minimum amount that is necessary for flood control purposes. However, this would contribute to an improvement of water quality (dissolved oxygen) only downstream of the Agassiz Bridge, but not meet standards elsewhere along the Muddy River. If additional sediment is removed in The Riverway and Olmsted Park ponds as part of habitat enhancement then the dissolved oxygen water quality standard could be met. In this manner, not only will organic compounds and heavy metal contaminants be removed, but the SOD and nutrients in the sediment will also be removed. Therefore, the proposed bank to bank sediment dredging alternative is the only alternative which will result in an increase of the dissolved oxygen above the Class B standard. It will be the initial step toward the long-term improvements to water quality in the Muddy River. The results of this alternative will be augmented by the implementation of a water quality-monitoring program and a BMP Plan (see Section 5.7 - Best Management Practices for Stormwater Runoff).

2.2.10 Screening of Water Quality Enhancement Alternatives

The alternatives to enhance water quality were screened to select those that resulted in the greatest long-term environmental benefit. While bank-to-bank dredging of the Back Bay Fens would produce a large short-term impact, the long-term environmental improvements that are synergistically derived from this alternative not only result in the maximum improvement of water quality, it also beneficially impacts aquatic and riparian habitat as well as historic and landscape restoration. The alternative to eliminate point sources was included as part of the No Action alternative since this program is on-going. The screening criteria are:



NOTE: DO levels associated with dredging are for initial conditions.

Figure 2-34
Water Quality Improvement Measure, Dredging Alternatives
Source: ACOE, July 1996

- Reduction of heavy metals and organic compounds in the sediments;
- Reduction of coliform, nutrients and solids;
- Increase in dissolved oxygen;
- Reduction of suspended sediment loading and floatables; and
- Reduction of the discharge of runoff contaminants.

The following alternatives were selected as at least partially meeting the water quality objective (See Figure 2-35).

- Dredging
  - Provides for significant increase in sediment quality;
  - Substantially reduces the sediment oxygen demand;
  - Increases dissolved oxygen in the water;
  - Reduces bio-accumulation in endemic species; and
  - Increases the aquatic and riparian habitat in area and volume.

- Best Management Practices
  - Reduces suspended sediment loads;
  - Reduces floatables and other debris;
  - Contributes to a reduction of bacteria;
  - Contributes to a reduction in nutrient loading; and
  - Results in an increase of dissolved oxygen.

Aeration, flow augmentation, and aquatic weed harvesting were eliminated because they did not contribute any more than would be realized through the dredging and BMP alternatives. Point source control activities were considered part of ongoing activities and therefore are part of the No Action alternative.

2.3 Enhancing Aquatic and Riparian Habitat

The existing aquatic and riparian habitat is severely degraded and has lost substantial diversity in the recent decades (See Appendix D). This environmental degradation is the net result of the loss of the wetland and shoreline planting masses along the Fens and Riverway, the presence of monocultures of turf and extensive stands of invasive vegetation that includes *Phragmites*, knotweed and glossy buckthorn, eroded banks and slopes, and the poor quality of watershed runoff.

The project objective of enhancing the aquatic and riparian habitat is accomplished by implementing several project elements including improvement of water and sediment quality, the removal of the extensive stands of invasive vegetation and the restoration of a more diverse assemblage of plant species along the banks and shoreline and the restoration of several islands. As a result of dredging of contaminated sediment for flood control and daylighting presently culverted sections of the River, there would

Alternatives	Improve Water Quality
Dredging	□
Point Source Control*	□
Best Management Practives	□
Flow Augmentation	
In-Stream Aeration	
Off-Stream Aeration	
Harvesting Aquatic Vegetation	

△	Fully Meets Objective
□	Partially Meets Objective
○	Addresses some elements of Objective
Blank	Does not Address Objective

* *To be included as No Action Alternative includes sewer separation and eliminating illegal connections*

Figure 2-35
Screening of Water Quality Alternatives

be a substantial increase in the volume of the aquatic habitat and improvements to water quality, and the benefits from the BMP Plans. The goal of this objective is to increase the size/volume, and the quality and diversity of the aquatic and riparian habitat. Again, this project objective is inter-related with the other project objectives in that implementing one objective would result in a beneficial effect on another. In this case, however, the objective must include the revegetation with substantial wetland and shoreline plantings.

In order to capitalize on these improvements, specific measures are designed into this project to further enhance the riparian and upland habitat as well. These are described below.

2.3.1 No Action

Under the No Action alternative for enhancing aquatic and riparian habitat none of the other project elements would be implemented. Some of the ongoing projects listed under Water Quality in 2.2 would slightly improve water quality. However, by not enhancing the aquatic and riparian habitat there would be no attempt to plant greater amounts of indigenous plant species other than those that remain after all construction is completed. Emergent wetland vegetation, shoreline plants, shrubs and canopy species would not be planted. Damaged turf and shoreline would not be re-vegetated with grass and damaged or lost shrubs would be replaced. This alternative also would not include the removal of *Phragmites*. The original shoreline would not be preserved and plants from the Olmsted plant list (see Section 6.2.2.4) would not be introduced. The wildlife habitat would remain essentially unchanged from the present.

The municipal projects that are currently underway and that are independent of the Muddy River Project would continue to be implemented. These include ongoing work by the BWSC and Brookline for sewer separation, the continuation of the Stony Brook Conduit Project, the implementation of the Boston Catch Basin Improvement Project, continuing the elimination of illegal cross connections, stormwater management and monitoring programs, infiltration/inflow controls, catch basin stenciling, public education programs, , permitting of large sewer users and regulation of industrial discharges, permitting of new or retrofitted building project through the BWSC's Site Plan Review procedure, other NPDES-related compliance efforts, and hazardous waste and used motor oil collections that are conducted by the City of Boston and Town of Brookline. The street sweeping and catch basin cleaning programs in both municipalities would be increased. While these programs would improve the quality of stormwater discharged into the river, they would result in minor improvements in the water quality of the river itself. The slight increase in water quality in the river achieved with these programs would have negligible positive impacts on the wetland and riparian habitat.

2.3.2 Improvement of Water Quality

As stated in Section 2.2, the improvement of water quality is one of the key goals of the Muddy River Project and is one of the most direct benefits that would result from the proposed flood control. The proposed project includes the removal of all antropogenic (culturally related) sediments in the River system for flood control. In this manner, not only will organic compounds and heavy metal contaminants be removed, but the SOD and nutrients in the sediment would also be removed. Although it may not be necessary to dredge all the sediments from The Riverway section For flood control purposes (it is only necessary to remove the *Phragmites* from The Riverway for flood control), The Riverway sediment removal would be the initial step toward the long-term improvements to water quality and the volumetric enhancement of the aquatic environment in the Muddy River. Removal of all the Riverway sediment would also result in an increase in the length of time that is needed for maintenance dredging of the Back Bay Fens by removing a large sediment source. Water quality and the conditions of the aquatic environment would be further enhanced by the implementation of a BMP Plan (see Section 5.6 - Best Management Practices for Stormwater Runoff), and a water quality-monitoring program. In turn, improved water quality and aquatic habitat conditions would result in an improvement of the fishery and the amount of predatory and other types of birds that utilize the aquatic and riparian habitats.

2.3.3 Bank to Bank Dredging

The goals of the Muddy River Project are so interconnected that the attainment of one goal (flood control for example) would result in the attainment of other goals (improvement of water quality, aquatic and riparian habitat and restoration is historic shorelines). The aquatic and riparian habitat would be enhanced by the improvement of sediment quality due to the removal of contaminated sediments and the return to native sediment quality. The native sediments are gravels and silts (see Appendix F) and provide better aquatic habitat than the existing contaminated sediments. The ACOE is also conducting tests that indicate some toxicity to benthic and fish resources that under the federal program can be used to justify dredging.

Dredging to improve the aquatic and riparian habitat involves bank to bank dredging within the shoreline of the Riverway, the Back Bay Fens, Charlesgate and dredging in the Leverett, Willow and Wards Ponds. Dredging in the river portions of the work includes complete *Phragmites* stalk root mat removal as well as other invasive species. The river could be dredged with 4 horizontal to 1 vertical side slopes and a bottom elevation that slopes from 4.01 to 3.25 BCB from the Leverett Pond outlet to Sears parking lot culvert, from 2.03 BCB to 1.03 BCB from Brookline Avenue to Ipswich Street and to an elevation of 1.03 BCB from Ipswich Street to the culverts to the Charles River. In addition, sediment and debris would be dredged from Wards Pond, Willow Pond and Leverett Pond and from the culverts and streams that connect them to each other and to The Riverway. Four feet of sediment would be dredged from Willow Pond and Leverett Pond would be dredged approximately 1.5 feet.

Bank to bank dredging differs from the partial dredging discussed in 2.1 by dredging more than required strictly for flood control. Specifically the partial dredging for flood control includes dredging a channel downstream of the former Sears parking lot to the Charles River. In some sections this is for all intents and purposes bank to bank, however in the wider sections of the Back Bay Fens the channel would be limited in width.

Bank to bank dredging would expand the width in Back Bay Fens to include removal of invasive species and more contaminated sediment. Bank to bank dredging in The Riverway could include sediment removal that in addition to the purpose of flood control would prevent downstream migration of remaining sediments due to higher flow velocities and to enhance the volume of habitat, improve water quality and return these areas to their historic configurations.

The proposed dredging could be performed using hydraulic methods as described in Section 2.1.5.1.

A combination of hydraulic dredging and mechanical dredging with small, specifically designed equipment may be required in the narrow, shallow river segments in the Riverway South. *Phragmites* would be removed by mechanical methods as discussed in Section 2.1.5.1.

Under the bank-to-bank dredging alternatives, the bottom of the river would be dredged to an elevation ranging from 4.0 BCB to 3.25 BCB from Huntington Avenue to Sears parking lot culvert. The current top of sediment elevation in The Riverway ranges from 4.0 to 7.0 BCB, or a water depth of 1 to 3 feet. Bank to bank dredging would result in approximately 20,200 cy of sediment and 10,000 cy of *Phragmites* removal. The sediment that is dredged from the Riverway would be pumped to a staging area that would be located at Netherlands Road. This staging area would be approximately 12,000 ft^2 and would be located on the roadway and the flat grassy area on the Boston side of the river adjacent to The Riverway.

Leverett Pond and Willow Pond could be dredged in their entirety to remove accumulated sediment that has substantially reduced the depth of these water bodies. Wards Pond could be dredged either in its entirety or only in the center. In order to preserve the diversity the habitat in the pond, dredging of only the center is proposed. The dredged sediment would be pumped to the Daisy Field staging area beside Leverett Pond.

2.3.4 Removal of Invasive Vegetation and Planting of Wetland and Riparian Vegetation

Monotypic stands of invasive species including *Phragmites* results in less biodiversity of the habitat. Removal of the invasive vegetation and replanting with the wetland and riparian vegetation enhances biodiversity of the habitat. The removal of invasive vegetation is necessary in order to attain the goals of flood control as well as the preservation of the historic shoreline. The Back Bay Fens and Riverway contain approximately 33,500 cy of *Phragmites* and root mat. The following is a discussion of the alternatives, which were considered in controlling the *Phragmites* and knotweed.

2.3.4.1 Covering *Phragmites* with Black Plastic

The BPRD conducted experimental controls of *Phragmites* with black plastic. This consisted of cutting and removing of the young stalks in the early summer and covering the cut area with black plastic tarp. At the end of the growing season the black plastic was removed. Shoots of the *Phragmites* began to emerge shortly after the plastic was taken away. The regenerating shoots did not mature that same year. However, in the following and successive years the *Phragmites* growth was not distinguishable from the surrounding plants. The use of black plastic was determined to be an unsuitable means of controlling the plant's growth and would have no effect on the extent of the root mat

2.3.4.2 Herbicides

Glyphosate herbicides are effective in controlling *Phragmites* and knotweed. The glyphosate herbicide is a systemic herbicide, which after application, translocates from the leaves to the roots and kills the plant. The herbicides may be applied from hand spraying with backpack sprayers or painted onto the plant leaves. It is best to apply the herbicide to the underside of the leaves. When this is not possible, surface application combined with a surfactant (detergent) that helps to breakdown the waxy coating on the leaf to enhance the expose between the herbicide and leaf tissue is recommended.

The glyphosate herbicides have been used to control *Phragmites* and knotweed for many years including parklands and wildlife refuges. The herbicides are relatively non-toxic to non-target species and have a low toxicity to fish and aquatic species. The active ingredient is biologically degradable and is also rendered inactive when it is exposed to suspended particles including algae in water or soil particles. Therefore, the toxicity effect of glyphosate is highest on the exposed leaf. Care must be taken to avoid drift of the mist with wind. This can be minimized by using low pressure hand spraying.

The effectiveness of the herbicide can be enhanced when the application is combined with cutting. By allowing young shoots of *Phragmites* or knotweed to reach approximately 1.5 feet in height, cutting them and then spraying the regenerating shoots will result in good control.

While application of herbicides would control the plant re-growth, it would do nothing to reduce the amount of root mat that is present. In order to accomplish the other objectives, the root mat must be removed. The removal of the majority of this volume of *Phragmites* plant and root mat would result in the direct increase to the volume and area of the aquatic and riparian habitat. In the place of the invasive plants, a diverse assemblage of emergent wetland, shoreline, and shrub plant species would be planted where only a monotypic plant habitat presently exists (see Section 6.0).

The use of glyphosate herbicides in minimizing the re-growth of *Phragmites* and knotweed is recommended (see Section 8.0 - Management and Maintenance Plan).

2.3.4.3 Mechanical Removal

Mechanical means of removing invasive species include excavators. Removal in water channels was discussed in Section 2.1.1.4. As part of bank restoration and regrading, invasive vegetation would be removed, in addition they would be removed to eliminate a monotypic habitat. Mechanical removal would remove the root mat to reduce regrowth of invasives.

2.3.4.4 Planting of Wetland and Riparian Vegetation

Once the *Phragmites* and other invasive vegetation has been removed, new vegetation must be planted in its place. The removal of the *Phragmites* and the restoration of the historic shoreline offers as much an opportunity to enhance the bio-diversity of the wetland and riparian habitat as it does to enhance historic resources. Where one or two monotypic species now exist multiples of species can be introduced and nurtured. In Section 6.2.2.2 - Aquatic and Wildlife Resources, the plan for enhancing the diversity of the wetland and riparian resources includes20 species of shrubs and trees from the original Olmsted planting list, six species of shoreline plants, and eleven species of emergent wetland plants.

In summary, the use herbicides and mechanical/physical removal are recommended because of their effectiveness. The use of black plastic is not effective and does not address any of the objectives for flood control, the objective to improve water quality, nor to enhance wetland and riparian habitat or landscape and historic resources.

2.3.5 Restoration of the Historic Islands and Enhancement of the Existing Island

Historic islands originally created by Olmsted would be restored in the Back Bay Fens and Willow Pond and the Babbling Brook. These islands do not exist presently but would be re-constructed and vegetated with wetland, shoreline and shrub vegetation for wildlife habitat. The historic island in the Back Bay Fens, documented on the 1921 survey of this area, was covered when the area at the Fens Bridge was culverted and filled. The historic island in Willow Pond was apparently removed in past dredging. In addition to the restoration of these historic islands the existing islands in The Riverway and Leverett Pond would be enhanced by removing accumulated sediment between the islands and the shoreline, thereby providing greater isolation for wildlife. One island in Leverett Pond which is denuded of vegetation could also be re-vegetated. All revegetation would follow the Olmsted massing and planting plans.

This alternative will increase the area of riparian habitat and enhance the habitat value by providing more isolated area for wildlife and increasing the ecotone (the edge effect between different habitat types)(see Figure 2-36).

Figure 2-36
View from St. Mary's Street Footbridge Thomas Ellison, 1910-12
Source: FLONHS

2.3.6 Enhancing Fish Spawning Habitat

The proposed project also presents an opportunity for a sub-objective to enhancing aquatic and riparian habitat because it would remove the present deposits of organic sediment and root mats along the shoreline which are not conducive to the spawning of a number of the common species of pan fish and game fish that inhabit the Muddy River. The proposed dredge will expose native granular sediments that will provide spawning habitat.

The proposed dredging will also have a beneficial impact on the spawning of anadromous fish. The blue back herring, which is, know to migrate into the Muddy River to Leverett Pond, spawns in the open water and its eggs sink to the bottom. Removal of contaminated sediment will increase the survival of herring eggs. Another anadromous fish, the shad, will migrate further into freshwater and spawn on sandy pebbly bottoms.

2.3.7 Restoration of Flow to the Babbling Brook

Presently, the Babbling Brook extends from Wards Pond to Willow Pond. Historically, the Babbling Brook also ran from Willow Pond to Leverett Pond. Water entered the Babbling Brook from Willow Pond through a flume that still exists under the dam and flowed under Willow Pond Road into the channel that is presently dry. Water from Willow Pond could also enter the dry extension of the Babbling Brook through a low flow outlet pipe that is in the Willow Pond dam (see Figure 2-37). The end of this low flow pipe is believed to be the outlet pipe that can be observed at thestone headwall below Willow Pond Road. Due to the accumulation of sediment in Willow Pond, the low flow outlet has become clogged. The proposed dredging of Willow Pond followed by cleaning of the pipe is believed to result in the restoration of flow to the Babbling Brook. The Babbling Brook should then have flow in it at all times, unless the blow off valve (below the low flow outlet pipe) on the dam is opened.

Restoration to flow in the lower portion of Babbling Brook would return viable aquatic habitat to the environment that was lost when the brook was redirected.

The proposed restoration work in the Babbling Brook above Willow Pond is based on the Emerald Necklace Master Plan. The work includes the removal of invasive vegetation and the planting of new vegetation. The historic island upstream of Willow Pond would be restored and its vegetation enhanced with low shrubs. The stream channel that would then bifurcate around the restored island could contain rocks in order to enhance the diversity of the aquatic habitat and the benthic resource populations.

2.3.8 Screening of Aquatic and Riparian Habitat Enhancement Alternatives

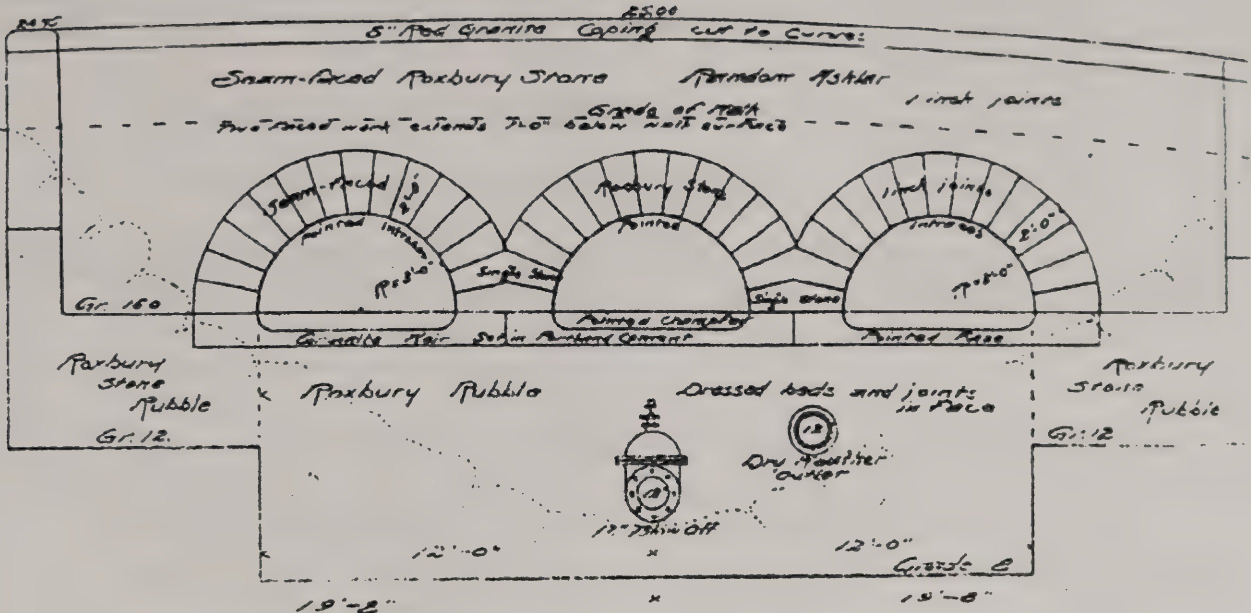
In order to screen the alternatives to enhance the aquatic and riparian habitat, it was first necessary to decide between two alternative approaches to the protection/restoration of the parks. The approaches were:

- A treatment plan to respect the Emerald Necklace Parks Master Plan (the continuum), or
- A treatment plan to respect the Primary/Secondary Periods of Significance (i.e., Olmsted and Shurtleff designs).

The treatment plant that would respect the Primary and Secondary Periods of Significance was not endorsed because of the substantial conflicts with modern land uses that would result from its implementation. The "continuum" treatment plan was decided upon because of its feasibility to implement and its compatibility with present day land uses and environmental laws and regulations.

Under the continuum alternative, the alternatives to enhance the aquatic and riparian habitat included the water quality enhancement alternatives plus:

- The removal of invasive species;
- Planting of wetland and riparian vegetation; and
- The restoration of the historic islands.



End Elevation developed on outer line of Coping

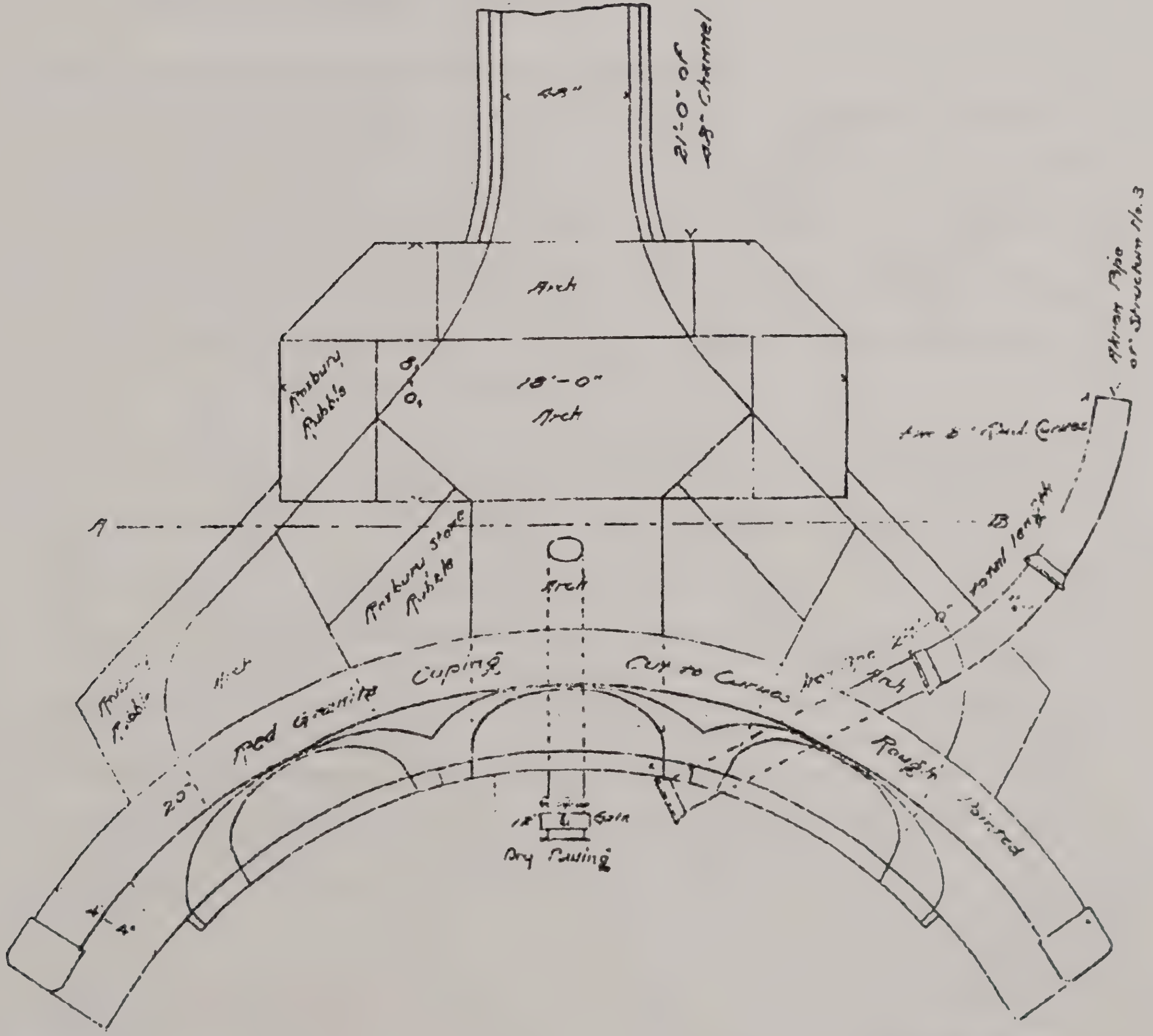


Figure 2-37
Willow Pond Headwall

- Enhancing fish spawning habitat
- Restoration of flow in the Babbling Brook

As is shown in Figure 2-38, the selected alternatives to enhance the aquatic and riparian habitat include dredging, point source control, Best Management Practices, removal of invasive species, planting of wetland and riparian vegetation, and the restoration of the historic islands.

2.4 Treatment of Landscape and Historic Resources

The Muddy River Project areas listed on the National Register of Historic Places, having been designed and constructed by the world renown landscape architect, Frederick Law Olmsted, and his firm and successors. Overtime, the historic integrity of the landscape has degraded as a result of such dynamics as urbanization and inadequate maintenance. Treatment of these landscape and historic resources to restore their former integrity for use is a significant objective of this project. Any restoration or treatment would have to be consistent with the Secretary of Interior Guidelines for the Treatment of Cultural Landscapes.

2.4.1 No Action (Preservation Treatment)

This alternative would not include the development of any plans for the historic restoration of plant materials, the shoreline, or such structural considerations as the treatments of culvert headwalls, or the restoration of the Babbling Brook or the historic island at Willow Pond. Under this No Action alternative the *Phragmites* would not be removed. However, by not providing for the treatment of landscape and historic features, there would not be any attempt to enhance the vegetative, or, the wildlife communities. Therefore, the No Action Alternative does not meet the objectives for enhancing landscape and Historic Resources.

The municipal projects that are currently underway and that are independent of the Muddy River Project would continue to be implemented. These include ongoing work by the BWSC and Brookline for sewer separation, the continuation of the Stony Brook Conduit Project, the implementation of the Boston Catch Basin Improvement Project, continuing the elimination of illegal cross connections, stormwater management programs, infiltration/inflow controls, catch basin stenciling, public education programs, hazardous waste and used motor oil collections, permitting of large sewer users and regulation of industrial discharges, permitting of new or retrofitted building project through the BWSC's Site Plan Review procedure, other NPDES-related compliance efforts. The street sweeping and catch basin cleaning programs in both municipalities would be increased. These programs have resulted in water quality improvements. Boston and Brookline would continue to maintain their respective portions of the Emerald Necklace.

Alternatives	Enhance Aquatic Riparian Habitat
Bank to Bank Dredging	△
Point Source Control - Water Quality Improvement	□
Best Management Practices - Water Quality Improvement	□
Remove Invasive Species	□
Plant Wetland and Riparian Vegetation	△
Restore Historic Islands	△
Enhancing Fish Spawning Habitat	□
Restoration of Flow to Babbling Brook	□

△	Fully Meets Objective
□	Partially Meets Objective
○	Addresses some elements of Objective
Blank	Does not Address Objective

Figure 2-38
Screening of Aquatic/Riparian Habitat Alternatives

2.4.2 Implementation of the 1990 Emerald Necklace Master Plan (Rehabilitation Treatment)

In 1983 legislation passed for a $32 million appropriation to restore, preserve and maintain twelve Olmsted-designed parks in five cities and towns across the state. In 1984, Massachusetts became the first state in the nation to initiate a program to restore the legacy for the future. The initiative, the Olmsted Historic Landscape Preservation Program is administered by the Commonwealth of Massachusetts Office of Environmental Affairs, Department of Environmental Management, Division of Planning and Development. The goal of the program was to create long-term rehabilitation frameworks to guide all future planning, management, maintenance and preservation action on these important pieces of our heritage.

The Emerald Necklace Master Plan Master Plan for The Emerald Necklace Parks – Jamaica Pond, Olmsted Park, Riverway & Back Bay Fens was produced under this program through the collaborative efforts of the Massachusetts Department of Environmental Management, the Metropolitan District Commission, the City of Boston and the Town of Brookline. The plan includes the park system from Charlesgate at the Charles River through Jamaica Pond. It is the product of a decade of planning and extensive consultation with the many individuals and groups who have a special connection to the Emerald Necklace Parks. The principal administrators of the parks are the City of Boston and the Town of Brookline, with the parkways since 1956 under the care and control of the Metropolitan District Commission. The master plan was adopted by the City of Boston and Town of Brookline in 1991.

This Master Plan provides an invaluable resource for the stewards of the Emerald Necklace. The recommendations set forth in the document are intended to provide a framework for decision-making and to lay the groundwork for preserving and restoring the genius of Olmsted's vision. The Emerald Necklace Master Plan weighs contemporary uses, existing physical condition and current maintenance and management capabilities of its owners, against the historical intent of the Olmsted park system in order to formulate a realistic strategy to respect the continuum of the parks.

The Project Objective for the treatment of landscape and historic resources under this scenario would be to develop a Treatment Plan to respect the Emerald Necklace Master Plan 1990, (the continuum). The treatment for the system collectively therefore would be Rehabilitation.

The following elements would be considered treatment to respect the 1990 master plan:

- Fully dredge the Muddy River, Leverett, Willow and Wards Ponds, thereby restoring the historic drainage capacity;

- Restore the banks, islands and historic plantings along dredged and disturbed areas in the Muddy River, Leverett, Willow and Wards Ponds;
- Daylight and restore the culverted section at Avenue Louis Pasteur restoring the banks, island and historic plantings;
- Daylight and restore the culverted section under the former Sear's parking restoring the bank and historic plantings;
- Remove non-native and native invasive species; and
- Enhance wetland and riparian habitat using as much of the Olmsted species list as possible.

2.4.3 The Primary and Secondary Periods of Significance (Restoration Treatment)

The Period of Significance of a landscape is defined by the National Park Service as the span of time for which a landscape attains historical significance and for which it meets National Register criteria. It is further defined as the meaning or value ascribed to a structure, landscape, object, or site based on the National Resister criteria for evaluation and normally stems from a combination of association and integrity. The following chart shows the relative periods of significance for areas along the Muddy River:

	Primary	Secondary
Charlesgate	1878-95	1910-31
Back Bay Fens	1878-95	1910-33
Riverway	1880-95	--
Olmsted Park	1880-95	--

Its association is the relationship between a historic event, activity, or person and the historic and cultural landscape. Association for a designed historic landscape, such as the Muddy River, is its association with its designer or designers. In the case of the Muddy River, this is Frederick Law Olmsted Sr. for The Riverway and Olmsted Park, and with both Frederick Law Olmsted Sr. and Arthur A. Shurtleff for the Back Bay Fens and Charlesgate.

The historical integrity is the authenticity of a historic or cultural landscape's historic identity, evidenced by the survival of physical characteristics that existed during its historic period. The degree of integrity is determined by the extent to which a landscape retains its historic appearance.

The Project Objective for the treatment of landscape and historic resources under this scenario would be to develop a Treatment Plan to respect the extant features of the Primary and Secondary Periods of Significance of the landscape. The treatment for the system collectively would therefore be Restoration of the landscape that is not only extant, but has association and integrity within the Periods of Significance.

The following elements would be considered treatment to Periods of Significance:

- Fully dredge the Muddy River, Leverett, Willow and Wards Ponds, thereby restoring the historic drainage capacity;
- Restore the banks, islands and historic plantings along dredged and disturbed areas in the Muddy River, Leverett, Willow and Wards Ponds back to the original shoreline detail, line and water level of the Period of Significance;
- Daylight and restore the culverted section at Avenue Louis Pasteur restoring the banks, island and historic plantings to the original shoreline detail, line and water level of the Period of Significance;
- Daylight and restore the currently culverted section under the former Sear's parking restoring the historic roadway configuration, gatehouse, bridge, banks, and historic plantings to the original shoreline detail, line and water level of the Period of Significance;
- Remove non-native and native invasive species; and
- Enhance wetland and riparian habitat using species from the Olmsted list for the Muddy River. Plant massings and layout would follow the historic planting plans, massing studies and view studies including species placement.

To truly return to the Periods of Significance would require Reconstruction of areas taken for roadway expansion and later elimination of uses, as well as the reconstruction of missing features such as gatehouses and bridges. The current philosophy of the National Park Service and in the preservation community in general is to respect the continuum of the site and therefore, to not restore or reconstruct to a given period. This course of returning to Period of Significance., therefore, would not be followed under current standards.

The alternative to develop a treatment plan that respects the "Continuum", offers more benefits than does a plan to respect the periods of significance. Therefore, the recommended alternatives include:

- Fully dredge the Muddy River, Leverett, Willow and Wards Ponds, thereby restoring the historic drainage capacity;
- Restore the banks, islands and historic plantings along dredged and disturbed
- areas in the Muddy River, Leverett, Willow and Wards Ponds;
- Daylight and restore the culverted section at Avenue Louis Pasteur restoring the
- banks, island and historic plantings;
- Daylight and restore the culverted section under the former Sears parking

- lot and restoring the bank and historic plantings;
- Remove non-native and native invasive species; and
- Enhance wetland and riparian habitat using as much of the Olmsted species list as possible.

2.5 Best Management Practices

Best Management Practices (BMPs) for urban runoff are nonstructural or low structurally intensive alternatives for control of urban runoff pollution. BMPs are less costly and more efficient than the alternative-using unit process to reduce pollutant loads. In addition to controlling pollution from urban runoff, BMPs also include benefits such as soil erosion control, flood control, and cleaner neighborhoods (Viessman and Hammer, 1998).

BMPs can be categorized as either structural or non-structural. Structural BMPs can also be classified as "treatment control" BMPs because they treat urban runoff rather than prevent it at its source. Non-structural BMPs also serve to control urban runoff, and are known as "source control" BMPs because they prevent or limit sediment and other contaminants in urban runoff, thereby controlling it at the source and preventing treatment which would otherwise be necessary. Educational measures and legislation or ordinances are also key components that contribute to the effectiveness of BMPs.

Instituting a Best Management Practices Plan is one of the five project objectives in the Phase 1 Plan. The objectives of the BMP plan are as follows:

- Minimize re-sedimentation rates
- Contribute to an improvement of water quality to Class B Water Quality Standards
- Maintain project improvements
- Reduce runoff volume
- Contribute to fishing and recreational uses in the Muddy River
- Contribute to fishable/swimmable goal for the Charles River and to contribute to attaining the Class B Water Quality Standards

Many alternatives were evaluated before the BMPs described in this report were selected for implementation. This section provides a brief discussion of the alternatives that were considered and includes those BMPs that are already being implementedwithin the watershed. The alternatives are divided into three major categories: No Action, Source Control Options, and Treatment Control Options. Most of the entities in the Muddy River Watershed currently have various structural (treatment control) and non-structural (source control) BMPs in place. Table 2-2

BMP	Type	Location	Notes
BWSC - NPDES Stormwater Management Program			
Catch Basin Maintenance Program	Non-structural	Various parts within the watershed	It is estimated that of the ≈ 30,000 CBs in Boston, each CB cleaned once per 3 yrs. The Program includes invenyory, mapping, and cleaning of catch basins and to develop a maintenance program. The NPDES requires inspection of all catch basins.
Storm Drain Maintenance Program	Non-structural	City-wide	
Illegal Sanitary Connections Remediation Program	Non-Structural	City-wide	As of 2000, 712 illegal connections were corrected city-wide, 30 were within the Muddy River drainage, 3 remain to be repaired under 2002 contracts.
Site Plan Review Process	Non-Structural	City-wide	Applications containing design plans and specifications for all proposed public and private connections to the sanitary and storm sewerage system must be reviewed and approved by the BWSC. Prohibits illegal connections, requires BMPs on storm drain connections, controls types of connections.
Stony Brook Improvement Project	Non-structural	Stony Brook drainage system	Program to eliminate CSOs and illegal connections upstream, clean accumulated sediment from within the Stony Brook conduit and associated storm sewers and to repair stormwater control structures. To be completed in 2002.
Particle Separators (Public)	Structural	Fenwood Road	An off-line separator on a 30" storm drain with a tributary atrea of ~ 30 acres.
	Structural	Perkins Street & Parkman Drive	An off-line separator (Vortechs Stormwater Treatment System) was installed by the BPRD as part of the Historic Restoration of Jamaica Pond.; The separator will be maintained by BWSC.
	Structural	City-wide	BWSC evaluates the feasibility of adding more separators under its CIP.
Particle Separators (Private)	Structural	City-wide	BWSC requires privately owned and maintained particle separators on all new storm drains serving parking areas and/or other paved surfaces greater than 7,500 ft.^{2} in size
Catch Basin Stenciling Program	Structural	City-wide	"Don't Dump" plaques are required on all new or rehabilitated catch basins and private owners are urged to do the same. Plaques are also installed when sidewalks are replaced.

Table 2-2 (1)

Existing Best Management Practices (BMPs)

Existing Best Management Practices (BMPs)
Phase I Muddy River Flood Control, Water Quality and Habitat Enhancement

Receiving Water Monitoring	Non-structural	Dorchester, West Roxbury	Receiving water sampling was conducted once during dry weather and two times during wet weather in the spring 2001. A third wet weather event was sampled in the fall of 2001. The data are being compiled.

BMP	Type	Location	Notes
City of Boston Public Works Department			
✓ Street Sweeping	Non-structural	City-wide	*Public Works Department - Highway Division* · 17 contract sweepers in Public Works Districts, daily (Mon.-Fri.), Apr.-Nov. · 7 contract sweepers in various areas, nightly (Mon.-Fri.), year-round · 1 contract sweeper on arterial routes, nightly (Mon.-Fri.), year-round · 7 contract sweepers in various areas, Sat. & Sun. nights, year-round · 7 City of Boston sweepers, city-wide, 7 days/week, year-round · 1,500 curb miles of city streets cleaned weekly · 75 "hand hokey" route cleaning personnel, highlight city area, 7 days/week · Public Works Dept. uses an avg. of 30,000 tons of salt/yr. on 785 mi. of road · approximately 110,000 cy per year removed from city streets
✓ Household Haz. Waste & Education Program	Non-structural	City-wide	prevents pollutants from entering the system; collection held twice yearly (spring & fall); residents notified by mail, newspaper & radio
✓ Paint & Waste Oil Collection Program	Non-structural	City-wide	collection centers, located in Roxbury, Hyde Park, Brighton & East Boston; open 1 day/month
✓ Management of Public Open Space Maintenance Practices	Non-structural	City-wide	· *BPRD*: Integrated Pest Mgmt. (IPM) systematic decrease in pesticide/toxic product usage; solid fertilizers only used · *MDC*: estimates ≈ 26 tons of salt/lane mile/year & 6 tons of sand/mile/year used on MDC managed roads
* notes from file	Non-structural	Various parts within the watershed	*BPRD* "The Design and Construction Division of the Boston Parks and Recreation Department (BPRD) is responsible for construction inspections. Sites are inspected on a weekly basis to ensure that sediment controls are in place. At the construction site, silt fences or hay bales are placed around existing catch basins." "The Department is aware of oil leaking from a former Brookline Public Works building underground storage tank. During rainstorms, groundwater carries the oil toward Willow Pond and Leverett Pond."

Table 2-2 (3)
Existing Best Management Practices (BMPs)

Existing Best Management Practices (BMPs)
Phase I Muddy River Flood Control, Water Quality and Habitat Enhancement

BMP	Type	Location	Notes
Town of Brookline Stormwater Management Plan (May 1998)			
✓ Section 1.0 - Introduction	Non-structural	Village Brook & Tannery Brook storm drain systems	between 1990-1995, water quality monitoring revealed over 20 illicit connections to sanitary sewers, most which have been removed
	Non-structural	Village Brook, Tannery Brook & Longwood Avenue storm drain systems	Jan. 1995 - Brookline enters into a Consent Agreement (CWA-2-I-95-1023) with EPA to address stormwater management practices within Town; required to investigate & remove illicit connections in Village Brook, Tannery Brook & Longwood Avenue Drainage Areas in accordance with a definitive schedule; Agreement also reqd. specific stormwater practices be implemented: · increase avg. rate of street sweeping to twice per month, · main streets in comm. areas sweeping increase to 3 times/week; · increase rate of CB cleaning on main streets in commercial areas to twice/year (includes ≈ 25% of Town CBs); · begin program to replace wire trash receptacles with solid; · volunteer program for CB stenciling
✓ Section 2.0 - Municipal and Regulatory Authority	Non-structural	Various parts of the watershed	Brookline does not maintain a list of companies/industries with approved discharges (non-contact cooling, unpolluted process discharges) to storm drains and/or natural outlet approved by the Commissioner
✓ Section 3.0 - Stormwater and Sanitary Sewer Systems	Non-structural	unknown	DPW records indicate one (1) active NPDES Permit (No. MAG 070010) issued to MWRA for dewatering during a construction project
	Info.	adjacent to Leverett Pond (west)	Report indicates a "Drainage Area 11: Muddy River", comprised of ≈ 5,640 lin. ft. of piping for 39 acres & discharges thru a 24-in. into Leverett Pond
✓ Section 4.0 - Existing Stormwater Management Practices			
Catch Basin (CB) Maintenance	Non-structural	Throughout Brookline	Current CB maintenance included insp. & cleaning of arterial roadway CBs twice/yr. & side streets once/yr.; CB condition & sed. vol. recorded on standard forms & entered into Town CB tracking database; current CB prog. is in compliance with the EPA Consent Agreement; Route 9 CBs cleaned once/yr. by MHD; a routing network (line coverage) is being developed for CB cleaning and would link current CB database info.; system would eventually be linked to the Town's GIS
Storm Drain Cleaning	Non-structural	Throughout Brookline	storm drain cleaning and/or television insp. conducted on case-by-case basis

BMP	Type	Location	Notes
Town of Brookline Stormwater Management Plan (May 1998)			
✓ Section 4.0 - Existing Stormwater Management Practices			
Street Sweeping	Non-structural	Throughout Brookline	"The Town conducts an extremely effective street sweeping program during the evening hours."; streets within the main comm. areas (Harvard, Washington and Beacon Streets & adjacent side streets) swept every 3rd day w/two (2) Town-owned and operated sweepers; two (2) remaining machines dedicated to the remainder of Town streets which are swept once/3 wks.; Route 9 annually swept by MHD; "...sweeping curtailed in the winter months"; removal of accumulated sand is a "priority" in the spring; Town sweeping prog. is in compliance with the Consent Agreement
De-icing of Municipal Streets	Non-structural	Throughout Brookline	currently uses sand to salt (sodium chloride) ratio of 7:1; Town plans to acquire equip. to apply calcium chloride; "Sand...is collected in the springtime through a rigorous street sweeping operation..."; Town has installed automated dispensing system in an unknown amount of de-icing trucks which dispensing 200 lbs. of mixture/lane mile; all 14 trucks will be automated by 1999; winter 1997-1998 = 3,600 tons of mixture used
Water Quality BMP Cleaning	Structural	Chestnut St. Drain/Willow Pond	There is a gross particle separator on the stormwater drainage system for the Chestnut Street Drain near Willow Pond; installed to intercept hydrocarbons generated from a 1995 petrol. release @ DPW; 1996 study indicated free phase petrol.. in soil; petrol.. in GW migrated to drain that discharged to Willow Pond. Additional Remedial actions considered incl. GW extraction & bioremediation. The separator is cleaned ≈ 3-4/yr.
	Structural	Cypress and Franklin Streets	An 11,000 gallon Vortechs Stormwater Treatment System particle separator was installed in December 1999.
Catch Basin Stenciling Program	Non-structural	Throughout Brookline	Stenciled message: "Don't Dump - Drains to the Muddy River"; Town appropriates funds annually to carry out the program that is implemented by volunteers, distributes brochures & flyers; program is in compliance with Consent Agreement; the Brookline Cons. Comm. (BCC) awarded a Lake & Pond Grant ($2,850.00) by DEM for stormwater education in the Hall's Pond drainage basin
Water Quality Controls for New Development	Possibly both	Throughout Brookline	soil erosion & sed. controls reqd. on all plans submitted to BCC; incl. all new development and const. projs. under Wetland Protection Act; reqd. to protect resources; new stormwater discharges proposed, BMPs must effectively remove 80% TSS as stipulated in the MSMP; maintenance & repairs exempt

Table 2-2 (5)

Existing Best Management Practices (BMPs)

Existing Best Management Practices (BMPs)
Phase I Muddy River Flood Control, Water Quality and Habitat Enhancement

BMP	Type	Location	Notes
Town of Brookline Stormwater Management Plan (May 1998)			
✓ Section 4.0 - Existing Stormwater Management Practices			
Illicit Connection Identification and Removal	Both	Village Brook & Tannery Brook	39 illicit connection detected; all connections either removed or scheduled to be removed by December 1997
	Structural	Longwood Avenue	four (4) homes determined to be cross-connected to the Longwood Ave. storm drainage system; conclusions = four homes immed. Connected to sanitary system; three homes unavailable for invest. be tested; repair drainage pipes in poor cond. as a result of TV inspec.; plugged drainage pipe discovered in sewer manhole to prevent storm overflow of sanitary wastes; after above were completed, contam. still evident, Town still investigating
Household Waste Disposal	Non-structural	Throughout Brookline	weekly curbside collection & disposal by Arthur Schofield Corp. (until 1999); 30% of solid waste stream recycled; in 1995 Town began replacing wire receptacles with solid, prog. to continue 'til 1998; household haz. waste collection day held twice/year, advertised thru newspaper, flyers & cable; in 1994 Town published "Brookline Environmental Guidebook", free to residents, avail. @ Town Hall; 3 stations in Town allow for waste oil drop-off
Structural Water Quality Controls	Structural	Throughout Brookline	"With the exception of basins that contain a drop inlet, each catch basin in town is equipped with an oil/water separator."
	Structural	Riverdale Parkway	Open bottom (for infiltration) deep sump catch basins were installed along Riverdale Parkway as it was being reconstructed.

BMP	Type	Location	Notes
Metropolitan District Commission (MDC) - Muddy River Maintenance Work Plan			
✓ Trash Barrels	Non-structural	Along the Muddy River	summer - daily; spring/fall - 1/3 days
✓ Litter Patrol	Non-structural	Along the Muddy River	weekly
✓ Catch Basins	Non-structural	Along the Muddy River	after grass season
✓ Street Sweeping	Non-structural	Along the Muddy River	“ideally once a week”
✓ Lawn Mowing	Non-structural	Bowker/Charlesgate, along fences, forrmer Kelly Rink site	every 10 days every 12 days
✓ Turf Maintenance	Non-structural	Bowker/Charlesgate, along fences, former Kelly Rink site	aeration, overseeding & fertilization during spring/fall by Boston & Brookline bi-weekly weed control by Boston & Brookline; no maintenance by MDC
✓Leaf Removal	Non-structural	Along the Muddy River	spring/fall
✓ Tree Planting/Pruning	Non-structural	Along the Muddy River	“spring-but having a problem with keeping new trees”; tree pruning 1/5 yrs.
✓ Rodent Control	Non-structural	Along the Muddy River	“Rodent contract - June and as needed”
✓ Roadway Patching	Structural		As needed
✓ Water Quality Controls	Structural	Leverett Pond	It is reported that a particle separator was installed on Jamaicaway drainage near the outlet of Leverett Pond.

Table 2-2 (7)
Existing Best Management Practices (BMPs)

shows an overview of the BMPs that are contained in published BMP Plans and which are currently being implemented by the entities involved in the project, including various departments of the City of Boston and Town of Brookline, as well as the Metropolitan District Commission (MDC).

Overall, on-going BMPs have reduced annual sediment loads in the Muddy River from an estimated 4,000 cubic yards in the 1970s to 2,500 cubic yards today. There is still room for improvement. A goal of this project is to reduce sediment loads by another 30% to extend the time before dredging is needed from 50 to 70 years. Figure 2-39 shows the goal for annual sediment loads of approximately 1800 cubic yards 2006.

The regulatory criteria regarding the implementation of BMPs include the EPA's Phase I and Phase II Guidelines as well as the DEP's Stormwater Guidelines. While there are no specific numeric criteria by which to determine which BMP should be selected, their combined effect is often more effective than any single BMP. Therefore, multiple BMPs were evaluated and selected.

2.5.1 No Action

The No Action alternative is to continue the existing stormwater BMPs that are already in place in the Muddy River watershed, without implementing any new BMPS or improving any existing BMPs. Without implementation of new BMPs, the sediment loads entering the Muddy River are predicted to be the same or just slightly less than the present estimate of 2,500 tons annually . Given the history of sediment accumulation in the Muddy River, this would result in similar dredging frequency of once every 30-50 years as shown in Figure 2-39. The information in Figure 2-39 was prepared by using the CDM Watershed Management Model (WMM). The 1970 base case was determined by using National Urban Runoff Program solids loading rates in the WMM. The year 2000 condition was modeled by using the results of water quality monitoring that was conducted as part of this EIR (see Section 4.0).

The municipal projects that are currently underway and that are independent of the Muddy River Project would continue to be implemented. These include ongoing work by the BWSC in complying with its 1999 NPDES Permit the removal of the sediment from the Stony Brook Conduit, and the implementation of the Boston Catch Basin Maintenance Project that includes the tracking of cleaning and maintenance of its catch basins. The Boston Parks and Recreation Department would continue its maintenance of the Emerald Necklace. Brookline would continue complying with its Consent Agreement with the Environmental Protection Agency (i.e., locating and correcting illegal sewer connections and sewer separation work), its street sweeping and catch basin program would continue, as would its maintenance of the Emerald Necklace park that is within Brookline.

2.5.2 Source Control Options

Controlling the sources of sediment in the Muddy River watershed rather than treating the stormwater runoff that contributes this sediment is preferred alternative.

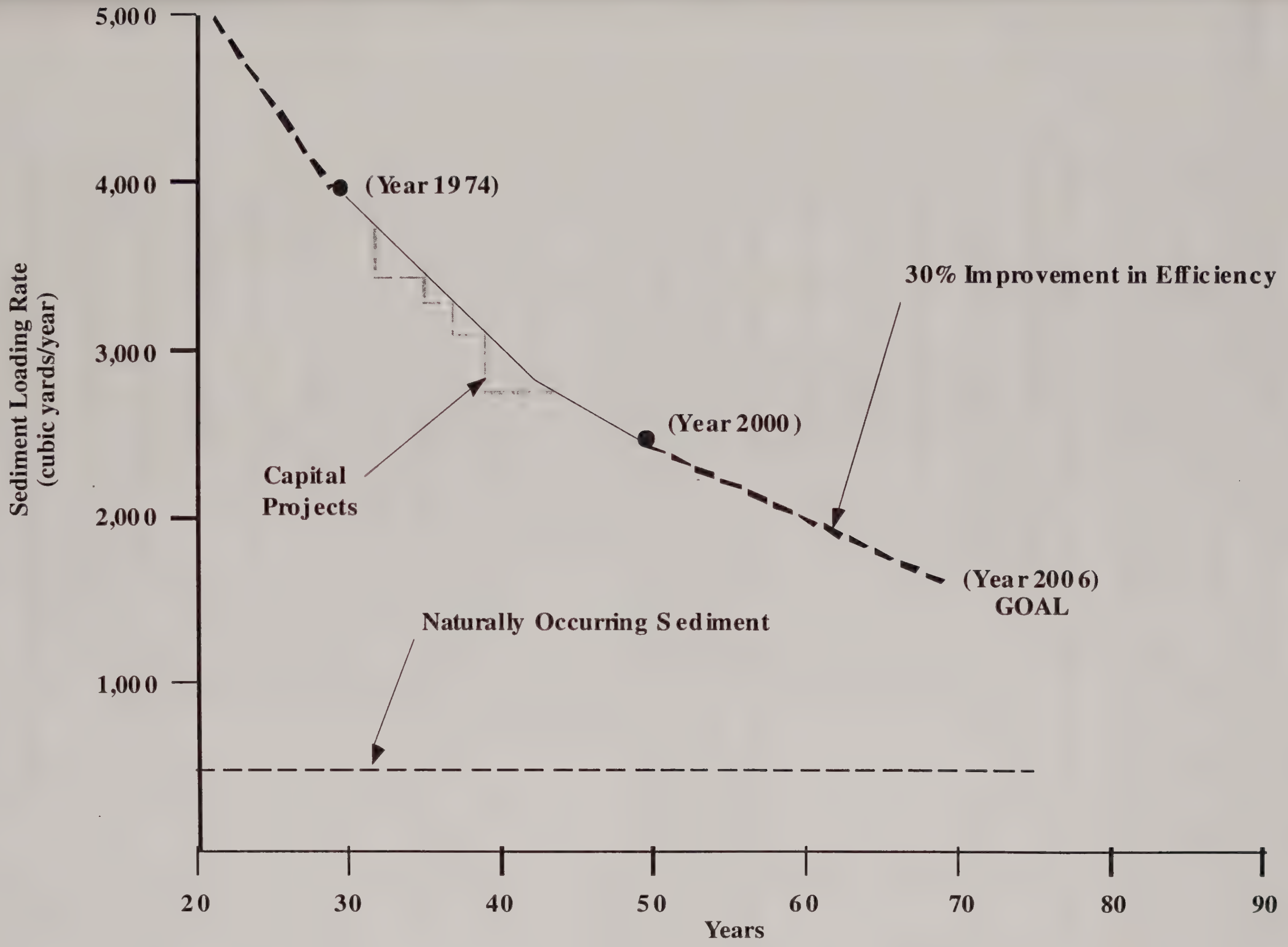


Figure 2-39
Sediment Loads Over Time

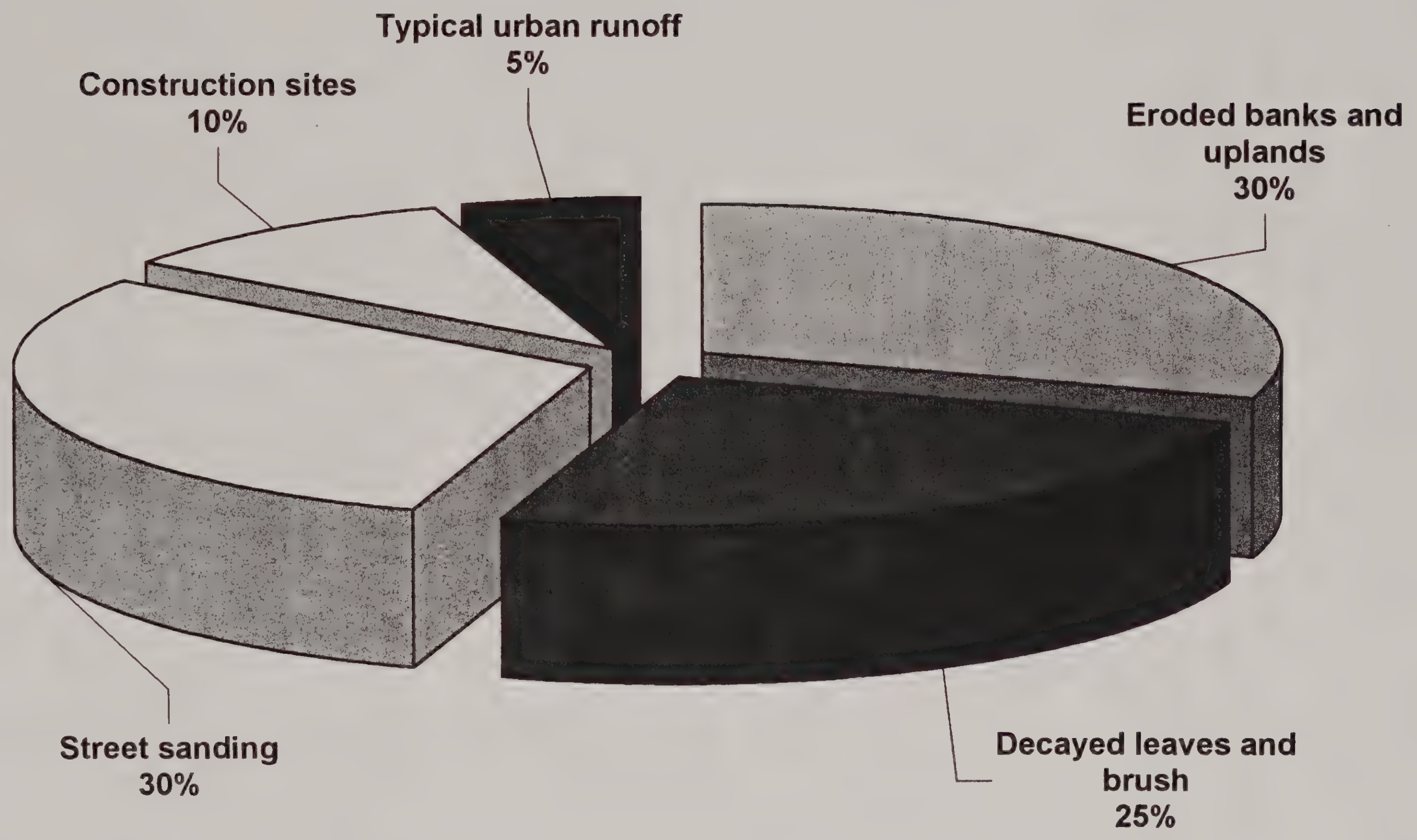
Figure 2-39 shows the sediment loadings to the Muddy River and how in recent years improvements to the drainage system have resulted in decreased sediment loads from approximately 4,000 cubic yards per year in 1974 to about 2,500 cubic yards per year in 2000. As the figure shows, historically, sediment loadings are following a decreasing trend, much of which is due to capital improvements and existing BMPs in place in the watersheds. However, sediment loadings are still high enough to cause resedimentation in the 30 to 50 year range. Target sediment loadings have been proposed to promote less frequent resedimentation. These target sediment loadings can be achieved by implementing the BMP Plan described in the following sections.

As shown in Figure 2-40, the major sources of sediment (and their proportional contributions to total load) are as follows:

- Eroding banks and uploads (30-60%)
- Decayed Leaves and brush (25%)
- Street sanding (30-60%)
- Construction sites (less than 10%)

Typical urban runoff-litter, animal waste (5% to 25%) Preventing and controlling sediments as its source, before it reaches the storm drainage system, is an effective strategy. Source control BMPs are measures that prevent constituents from being released into the environment and/or clean them up before they can enter the drainage system. Types of source control BMPs that were considered for inclusion into the BMP plan are:

- Catch basin cleaning;
- Catch basin stenciling and signs;
- Combined sewer separation and sewer system cleaning;
- Household hazardous waste and education;
- Illicit connection control;
- Lawn, garden, and park maintenance;
- Roadway patching/repair;
- Street sweeping and pavement deicing;
- Stormwater bylaws and town ordinances;
- Stormwater guidelines for selected industries and businesses;



Data sources: Corps of Engineers, USEPA, MADEP

Figure 2-40
Sources of Sediment
Source: CDM, Inc.

Both the City of Boston and Town of Brookline currently are implementing the majority of these source controls BMPs to varying extents. Table 2-2 shows the matrix of specific measures by community, where BWSC is the Boston Water and Sewer Commission, PWDW is the Boston Public Works Department, BPRD is the Boston Parks and Recreation Department, and MDC is the Metropolitan District Commission. The following sections describe the types of BMPs considered for the Muddy River BMP plan, as well as the actions that are currently being taken, and what additional steps are necessary to improve BMPs in the watershed

2.5.2.1 Catch Basin Cleaning

Catchbasin cleaning removes accumulated sediments from catchbasins on a regular basis. Regular catchbasin cleaning programs allow effective removal of pollutants, reduce high pollutant slugs during the first flush storms and, prevent clogging of downstream systems, and restores the catchbasins sediment trapping capacity. Clean catchbasins allow the in-system storage capacity of storm drains to be fully utilized..

The town of Brookline, the BWSC, and the MDC have catch basin cleaning programs with varying levels of effectiveness. The Town of Brookline currently has a regular catch basin cleaning and maintenance program, however there is room for improvement as indicated by the large amounts of sediment that is entering the Muddy River via the Village Brook Drain and Chestnut Street drain.

Currently, the catchbasin maintenance program in Brookline provides for inspection and cleaning of arterial roadway catchbasins twice annually and catchbasins on side streets once per year. A routing network (line coverage) is being developed for catchbasin cleaning and would link the current catchbasin database information to a GIS. Improvements in data collection efforts for the Town of Brookline would determine whether the current catchbasin maintenance schedule provides for frequent enough cleaning or whether increased cleaning frequency is needed for some catch basins. In addition, a Pilot Plan is a recommended addition to the Brookline BMP Plan. As described in Section 2.5.2.8, the Pilot Plan will provide for the tracking of roadway sand, leaves and other debris that are recovered through street sweeping and catch basin cleaning.

In mid-December 2000, the BWSC began a multi-year, multi-million dollar project to identify, inspect and clean the catch basins citywide. Phase I (completed) of this project consists of surveying and inspecting all of the BWSC catch basins in the City to verify locations of existing basins, identify and map new basins, and identify maintenance and repair needs. Phase II of the project that is underway, involves cleaning of the BWSC catch basins. Under Phase III are catch basin preventative maintenance plans that will be developed by using information from the previous two phases to estimated grit accumulation rates and associate them with characteristic areas and topography. The goal is to then tailor the maintenance schedule to more frequently clean those catchbasins with the greatest accumulation.

The MDC does not have a formal program for catchbasin cleaning and inventory. MDC catch basins reportedly are cleaned a minimum of two times per year. Generally, the MDC has area foremen who are responsible for a certain district and are in their areas 2-5 times per week. In addition to the biannual cleaning, the area foremen are responsible for checking and cleaning catch basins after large storms. However, field reconnaissance done as part of this study identified MDC catch basins that were full of sediment in The Riverway. In addition to being full of sediment, numerous MDC catchbasins in the Muddy River watershed are in poor structural shape and need repair and replacement. These findings are in conflict with the MDC's BMP Plan which requires that catch basins be cleaned (see Table 2-2, page 6 of 6). The MDC currently does not have a separate budget specifically for catch basin cleaning, rather the budget for each district includes all maintenance items grouped into one budget.

2.5.2.2 Catch Basin Stenciling

While catch basins prevent most pollutants from entering a storm drain pipe, some pollutants, such as oil and pet waste can enter a drain and discharge to the waterways. Gasoline, antifreeze, pet waste, cigarette butts, cleaning agents, pesticides, fertilizers, and trash are all pollutants that are illegally dumped on city streets where they are picked up in storm water runoff that enters storm drains through catchbasins. From the catch basins, these pollutants can discharge from the storm drain system to Boston's rivers, beaches, and harbor and cause serious water quality degradation (www.Bwsc.org). The main purpose of catchbasin stenciling programs is for education and to prevent illegal dumping of contaminants into the storm drain system.

Catch basin stenciling is currently being conducted by the BWSC, the MDC, and volunteers in the Town of Brookline. However during field reconnaissance many catch basins in all three jurisdictions were identified that were not stenciled. This is a potential area of improvement for the three entities.

The BWSC storm drain stenciling program has been designed. The program is designed to inform people that much of what is dumped on our streets ends up in our rivers, beaches and harbor. The BWSC is working with local schools, watershed and neighborhood groups to educate the public and stencil "Don't Dump, Drains to..." messages next to catch basins throughout the city. The stenciled message alerts the public that what is dumped in catch basins and on our streets can end up in one of Boston's waterways. In addition to stenciling, BWSC also requires permanent plaques on new and repaired catch basins installed by contractors on public land and requests that private developers do the same on private properties. Cooperation between the BWSC and the public can produce outstanding results. The storm drain-stenciling program would add to the continuing and successful efforts of Boston and its surrounding communities to clean our local waterways (www.Bwsc.org).

2.5.2.3 Combined Sewer Separation and Sewer System Cleaning

Combined sewer separation is the process of separating the sanitary sewers from the storm drain system. This ensures that the flow from sanitary sewers is treated by a wastewater treatment plant and to prevent combined sewer overflows from discharging into a water body during large rainfall events. The only combined sewer outlet from Boston into the Muddy River is the Stony Brook Conduit. The Stony Brook Conduit discharges at the downstream end of the Muddy River, near its confluence with the Charles River. The Stony Brook Conduit does not always discharge into the Muddy River. It overflows into the Muddy River only during periods of high rain.

Storm drain cleaning helps to remove pollutants from the sewer system to ensure that the pipes convey their intended design flow as well as allowing the in-system storage capacity to the drains to be fully utilized. This is part of the goal of the cleaning project in the Stony Brook conduit and repairs to the Boston Gatehouses and the Charlesgate East Gatehouse. The BWSC is currently in the process of completing two projects that would mitigate and eventually eliminate combined sewer overflows into the Muddy River. One of the projects involves cleaning the Stony Brook Conduit, which would provide for increased flow capacity. The Stony Brook Sewer Separation project is also currently underway, which separates the sanitary sewers and storm drains . This will eliminate combined sewage from the periodic overflows from the rehabilitated Stony Brook Conduit drainage system. However, during periods of high runoff, estimated to be two times per year, the Stony Brook Conduit will overflow into the Muddy River, without the presence of sewage.

As part of the Muddy River Project, the BPRD developed plans and details for the separation of surface runoff from the Back Bay Yard and the sanitary sewer that passes under the site. The project was included in a Notice of Project Change that was in the Environmental Monitor on August 22, 2001 included the construction of 300 linear feet of storm drain with 2 hooded catch basins and a deep sump manhole with an extended hood. The primary discharge mode from the reconfigured storm drain would be via an infiltration chamber that is to be constructed upland from the Muddy River. The MEPA Certificate on the Notice of Project Change indicated that no further MEPA review is required. The BPRD filed the plans with the Boston Conservation Commission and has received its Order of Conditions. This construction will take place in 2002 on a schedule that is independent of either the Charlesgate dredging or the balance of the dredging and other rehabilitation work.

In the town of Brookline, 95% of the storm drains system is separated from the sanitary sewer system, and the remaining combined systems do not discharge to the Muddy River.

2.5.2.4 Illegal Connection Control

Illegal sewer connections are a violation of the BWSC's NPDES Permit that requires compliance with the Clean Water Act as well as the BWSC's Regulations Governing the Use of Sanitary and Combined Sewers and Storm Drains. Illegal connection control includes preventing, detecting, and removing all physical connections to the drainage system that convey any material other than storm water.

The regulation of connections to the municipal storm drainage system is considered to be a BMP for both the Town of Brookline and the City of Boston. Because the on-going outfall monitoring results do not result in as frequent findings of domestic waste in the storm drains as before, it is felt that most of the illegal sanitary sewer connections have already been identified and corrected Monitoring and progress in the removal of other illegal connections will continue as they are found.

Since 1986 when the BWSC's Illegal Sanitary Connection Remediation Program began, 712 illegal connections have been corrected citywide, including 30 in the Muddy River watershed (2000 Annual Stormwater Management Report, April 2001, Boston Water and Sewer Commission). Thirteen new illegal connections were found in 2000 and are being added to Commission contracts for correction. The Brookline illegal sanitary remediation program has identified and corrected 39 illegal sewer connections.

2.5.2.5 Household Hazardous Waste and Waste Oil Collection and Education

The house hold hazardous waste collection and education programs are to minimize the purchase and use, and to encourage residents to properly store and dispose household hazardous materials. Household hazardous materials are those that exhibit characteristics such as corrosive, ignitability, reactivity, and/or toxicity, or are listed as hazardous materials by the EPA (Ferguson et al, 1997).

The Town of Brookline and the Boston Public Works Department currently have programs for household hazardous waste and education. The City of Boston has four hazardous waste collection centers for paints and motor oil only. Boston also has household hazardous waste collections four times each year. Brookline also has a hazardous waste collection day every spring, and provides options and contact information for residents who have hazardous materials for which they need to dispose of immediately.

Potential recommendations to the hazardous waste programs for both entities could include increasing the amount of hazardous waste collection days to more than one day per year and, to provide hazardous waste collection in the neighborhoods where people without cars can take unused paint, cleaners, etc. for collection.

2.5.2.6 Lawn, Garden, and Park Maintenance

Existing BMPs that deal with lawn, garden and park maintenance include the following:

- Leaf removal-twice annually (spring and fall)
- Tree planting/pruning annually

- Turf maintenance including aeration, over-seeding and fertilization is completed annually in the spring and fall

One area of improvement in lawn, park and garden maintenance that is in-place by Boston and Brookline is a program to educate residents in both Boston and Brookline on the hazards of pesticides and herbicides and alternative methods for pest and weed control. Use of pesticides in the Victory Gardens could also be a significant factor in pollutant runoff into the Muddy River. Water originating from drainage tiles under the Victory Gardens will be checked as part of the Monitoring and Maintenance Plan (see Section 8.0) The Victory Garden users have expressed their interest in determining if the Gardens are a source of pollution and to take steps to educate its members.

Increased trail maintenance and re-vegetation is another BMP, which is in need of improvement. Regular trail maintenance and re-vegetation would limit sediment erosion on pathways and would also increase and aesthetic value of the park. In addition, a prohibition on the use of trail bikes within the Emerald Necklace parks would not only reduce erosion and sedimentation, but enhance the level of effectiveness of trail maintenance activities. The compost piles in the Victory Gardens should also be removed further from the Muddy River and the drainage from the compost piles should flow either overland over well grassed areas, and/or enter the Muddy River via a wetland swale.

2.5.2.7 Street Sweeping

The goal of street sweeping programs is to reduce pollutant discharges (principally sediment) to storm water systems by cleaning pavement regularly with a combination of mechanical broom sweepers and vacuum sweepers. (Fergusan et al., 1997).

Increasing the frequency of street sweeping and improving the equipment used in street sweeping is another important stormwater best management practice. Regular street sweeping prevents sediment from reaching the storm drainage system. The Town of Brookline currently has an effective street sweeping program already in place. Frequency of street sweeping varies by neighborhood. Streets with the major commercial areas (Harvard Ave., Washington and Beacon St.) are swept every third day. The remaining streets in the Town are swept once every three weeks with street sweeping curtailed in the winter months. One of the major reasons for the effectiveness of the street sweeping program in Brookline is the restriction of no overnight street parking. This policy is strictly enforced by the Brookline Police Department by ticketing and towing of vehicles that are parked overnight or between the posted hours of street sweeping.

The City of Boston has a street sweeping program that includes the following:

- 17 contract sweepers in Public Works Districts, daily (M-F), April-November
- 7 contract sweepers in various areas, nightly (M-F) year-round

- 1 contract sweepers on arterial routes, nightly, (Sa-Sun), year-round
- 7 City of Boston sweepers, city-wide, 7 days/ week, year-round
- 1500 curb miles of city streets cleaned weekly

However, because many of the city streets in the Muddy River watershed are not swept, the street sweeping program for the City of Boston is in need of improvements and must include all streets within the Muddy River watershed. Most notably, a policy of ticketing and towing rather than just ticketing for violators parked in posted areas where street sweeping is scheduled to occur would enhance the City's ability to conduct its work. The Boston Transportation Department and the Public Works Department have embarked on a trial program in the Fenway area to perform street sweeping. Alternatives that were considered to assist Boston in upgrading the frequency and effectiveness of their street sweeping program in the Muddy River watershed include investigating alternative parking for residents, not only in The Fenway, but other sections of the City. These alternative parking measures include communicating with colleges in the area to allow residents on selected streets to park in a designated campus lot on the scheduled day for street sweeping in their neighborhood.

Street sweeping in parts of the Muddy River watershed under MDC jurisdiction (The Riverway, Park Drive, The Fenway, etc.) also needs improvement. The streets in the Muddy River watershed are swept a minimum of 4 times per year, or once per season. Sometimes the streets are swept more frequently, however no formal schedule (i.e. the first and third Tuesday of each month) is in place for the MDC roadways. MDC staff post signs approximately 48 hours before street sweeping and then tow cars the morning before street sweeping is to occur. With the assistance of the State Police which tags illegally parked vehicles, the MDC enforces the towing of vehicles violating the parking restrictions. Currently there are not specific funds set aside for street sweeping by the MDC, the funds are taken out of the general maintenance budget.

2.5.2.8 Pavement Deicing

Pavement deicing as a BMP is to limit the application of salt, deicing chemicals and abrasives to the minimum amount necessary for effectiveness snow and ice control.

Deicing materials such as salt, CMA(manufactured from dolomitic limestone and acetic acid), calcium chloride, urea, ethylene glycol, diethylene glycol, methanol, and propylene glycol all have significant negative impacts on surface waters. Liquid calcium chloride mixtures are also an alternative deicing technique that helps in the control of ice. A narrow band of roadway and air temperatures are critical in the effectiveness of this technique. However, alternative methods are 5-15 more times costly than road salt. The Town of Brookline has experimented with the liquid mixture and found that it was not as effective, possible due to the variable air and roadway temperatures due to the hilly terrain in the town. Limiting the application of salt and deicing chemicals to the minimum necessary for snow and ice control is a cost effective BMP (Ferguson et al., 1997). The amount of sand and salt used in roadways in the winter is a significant source of sediment to urban watersheds. Communities are faced with a conflicting situation, to use large amounts of sand and salt to ensure the safest roadways for motorists at the expense of sediment filling up the stream channel and potentially leading to flooding problems.

Currently none of the entities in Muddy River watershed, with the exception of Brookline can accurately account for the amounts of salt and sand that are applied to the roadways. Brookline does have a computerized system for the application of sand and salt to the roads. A proposed addition to the BMPs for Brookline is a Pilot Plan to annually account for the amount of sand that is applied to the streets, removed from the streets via street sweeping, and that which is removed from the storm drain system via catch basin cleaning. The goal of this Pilot Plan is to gather data to develop annual recovery rates for sand on a Town-wide basis and, if possible, by watershed areas. For the City of Boston and the MDC, alternatives that were considered include developing alternative methods of pavement deicing and better accounting of the sand and salt that is applied to the roadways annually.

2.5.2.9 Stormwater Bylaws

Stormwater bylaws, such as those that deal with waterfowl control and "pooper scooper" ordinances, were considered for inclusion into the BMP plan for the Muddy River watershed.

Waterfowl control is a significant but often overlooked BMP that is an important consideration for the Muddy River watershed because of its easily accessible banks. Both the Town of Brookline and City of Boston should develop a goose and duck control bylaw that prohibits the feeding of ducks and geese. In addition, vegetation could be planted which would limit waterfowl access to certain areas of the stream banks.

Both the Town of Brookline and the City of Boston have "Pooper Scooper" Laws require pet owners to clean up after their pets. The City of Boston's "Pooper Scooper Law" covers any waste left by dogs on sidewalks, streets, parks, and neighbors' yards. Violation of this regulation is punishable by a fine of $50 for each occurrence (www.*Bwsc.org)*. Increased enforcement of the existing "pooper scooper" laws in both Boston and Brookline is also necessary. Suggestions for improving the enforcement of owners cleaning up after their pets include providing plastic bags and trash receptacles for pet waste. Increased signage in the park areas is also recommended. Enforcement should be conducted by the Park Rangers and the respective Animal Control Officers.

2.5.2.10 Stormwater Guidelines and/or Water Quality Controls for New Development

Stormwater guidelines or town ordinances requiring the use of onsite BMPs on private property were also considered as a BMP. These guidelines would be site specific and could perhaps provide tax-incentives for property owners who install onsite BMPs in efforts to reduce stormwater quality and enhance stormwater quality.

Currently, the Town of Brookline has water quality controls for new development while the Boston Water and Sewer Commission has specific regulations for developers installing new sewer and storm drain connections. However, more stringent stormwater guidelines are recommended for both public and private entities such as Brookline upgrading its BMP Plan to comply with EPA Phase II requirements.

The BWSC has its Site Plan Review process which requires the submission of plans and specifications for the review and approval of all connections to the sanitary and/or storm sewerage system. Since 1992, the BWSC has required the installation of particle separators to improve the quality of stormwater discharges from new parking lots and paved areas. The type and capacity of the separator is dependent on the size if the tributary area. For new developments, the BWSC requires that stormwater be retained on-site, whenever site conditions permit.

2.5.2.11 Other

Other possible measures that were evaluated for their effectiveness and feasibility as stormwater BMPs include the following:

- Decreasing the maximum allowable lot coverage;
- Encouraging structured or covered parking;
- Reduction in the number of parking spaces required by encouraging alternate commuting modes. Ways to encourage alternate commuting modes include subsidizing public transit passes and fares, as well as promoting alternative methods of transportation such as biking to work. An example to the following is the City of Cambridge, which has bike lanes on some major streets. The City of Cambridge also has an annual "Bike to Work" day to promote this practice.
- "Green roofs" are roofs which limit the amount of runoff into the storm drain system. Planting vegetation on house or garage roofs provides a method of water collection to slow down and limit the amount of water, which actually enters the storm drain due to the uptake of the vegetation. Green roofs also provide aesthetic value to property. Similarly, encouraging the reuse of roof runoff on site for infiltration, irrigation, or cooling water also reduces the amount of roof drainage entering the storm drain system.
- Restoration of eroded banks and paths in The Riverway is a BMP in the form of sediment control. Restoring eroded banks using either traditional stream restoration techniques or more bioengineering techniques including re-vegetation would provide a method of sediment control as well as providing aesthetic value in the Riverway.

- Correcting MDC curb settings was considered as a BMP, which should be incorporated into the Plan due to the deteriorating condition of some curb settings along MDC roadways namely along the Riverway. The currently sunken/broken curbs, low curb settings, and clogged catch basins cause runoff to erode the roadway embankments and the eroded soil flows into the Muddy River.

- Addressing the condition of private ways in Brookline. Private ways in Brookline often do not receive proper maintenance, which also leads to pavement erosion. Runoff from these private ways could contribute sediment loads, which could otherwise be prevented from more frequent maintenance by owners of these private ways.

- Capital improvements to the drainage system.

- The addition of oil/water separators for parking lots and streets that are highly traveled by slow stop and go traffic as this type of travel results in higher contamination than does highway/parkway type driving.

- When undertaking capital improvements to the drainage system, BWSC evaluates whether installation of particle separators is feasible. In the Muddy River watershed, The BPRD installed and the BWSC will maintain a particle separator off Perkins St.. The BWSC also has a particle separator on Fenwood Road. For new developments, BWSC requires stormwater to be retains onsite whenever site conditions permit. Since 1992, BWSC has required the installation of particle separators to improve the quality of stormwater discharge from new outdoor parking lots and paved areas. The type and capacity of the separator required is dependent on the size of the outdoor pavement tributary area.

2.5.3 Treatment Control Options

Treatment control BMPs are practices installed into drainage systems that control runoff volumes/velocities and/or removed constituents from runoff. Factors that affected the selection of BMP alternatives for the Muddy River watershed include the following watershed characteristics:

- High imperviousness (40-60%);

- Little non-utilized open space, highly urbanized watershed;

- Historic park setting versus upstream in watershed;

- High storm runoff (180 million gallons for design storm) versus hydraulic capacity of stream

- Other factors that were taken into consideration in selecting BMPs for the Muddy River watershed were the engineering feasibility of the particular sites, as well as the soil conditions and the depth to groundwater.

A water quality-monitoring program should be implemented to collect baseline water quality data before the new BMP plan is fully implemented. Sampling should continue for a period of 5 to 7 years, to measure the effects of existing BMPs on water quality in the Muddy River, and to evaluate the improvements to water quality as a result of new BMP measures that would be put into place.

A Pilot Plan is also recommended to evaluate the performance and effectiveness of existing particle separators. The information gathered from the Pilot Plan would be useful in designing and determining placement of new particle separators at various locations in the watershed.

Among the treatment control BMPs that were evaluated for the Muddy River watershed were the Center for Watershed Protection's recommendation for specific sites in the Village Brook watershed. The consultant has carefully reviewed the recommendations of the Center for Watershed Protection and selected several of the structural BMPs, as described in Section 5.7. However, a more detailed evaluation of the recommended alternatives (such as in a Pilot Plan) is needed for design or implementation. The alternatives listed in then Center for Watershed Protection's Report would be evaluated in terms of engineering feasibility and cost. The results of a water quality monitoring program and the Pilot Plan on particle separators would be used in conjunction with further evaluation of the Center for Watershed Protection's recommendations in determining placement of treatment control BMPs in the Muddy River watershed.

In general, the types of treatment control BMPs that were evaluated include the following:

- Constructed Wetlands

  Constructed wetland systems incorporate the natural functions of wetlands to aid in pollutant removal from storm water. Constructed wetlands can also provide for quantity control of storm water by providing a significant volume of ponded water above the permanent pool elevation. Constructed wetland systems have limits to their application. A water balance must be performed to determine the availability of water to sustain the aquatic vegetation between runoff events and during dry periods. In addition, a sediment forebay or some other pre-treatment device should be incorporated into the wetland system design to allow for the removal of coarse sediments that can degrade the performance of the system. Constructed wetlands are particularly appropriate where groundwater levels are close to the surface because groundwater can supply the water necessary to sustain the wetland system. (EPA, 1999) These facilities also require significant land area for implementation to be effective.

- Wet Retention Ponds

  Wet retention ponds are small, man-made lakes with emergent wetland vegetation around the banks designed to capture and remove particulate and certain dissolved constituents. Wet ponds are ideal for large, regional tributary areas (10-300 acres) where high removal efficiency of particulates is needed (Ferguson et. al, 1997). Retention ponds provide both water quality improvements and quantity control, as well as providing aesthetic value and aquatic and terrestrial habitat for a variety of plants and animals.

Pollutant removal in retention ponds can occur through a number of mechanisms. The main mechanism is the removal of suspended solids and associated pollutants through gravity settling. Aquatic plants and microorganisms can also provide uptake of nutrients and degradation of organic contaminants. Retention basins that incorporate an aquatic bench around the perimeter of the basin that is lined with aquatic vegetation can have an added pollutant removal efficiency. This littoral zone can aid in pollutant removal efficiency by incorporating mechanisms found in wetland systems. These mechanisms include removal of sediment by filtration by aquatic plants, removal of metals and nutrients through biological uptake by aquatic vegetation and degradation or organic contaminants. If the bottom of the pond is not lined, then infiltration can occur aiding in the maintenance of local groundwater supplies (EPA, 1999).

- Vegetated swales (Biotreatment)

Vegetated swales are broad, shallow channels with a dense stand of vegetation covering the side slopes and channel bottom. Vegetated swales are designed to slowly convey storm water runoff while trapping pollutants, promoting infiltration, and reducing flow velocities. Vegetated swales can either be wet or dry. Dry swales should be used in areas where standing water is not desired, such as in residential areas. Wet swales can be used where standing water does not create a nuisance problem and where the groundwater level is close enough to the surface to maintain the permanent pool in inter-event periods. Wet swales provide the added benefit of being able to include a range of wetland vegetation to aid in pollutant removal. (EPA, 1999) A diagram of a typical vegetated swale is shown in Figure 2-41. Swales and filter strips were evaluated for their feasibility in several areas of the Muddy River watershed, namely the Victory Gardens in the Back Bay Fens. Grass swales remove up to 90% of suspended materials, 20% of dissolved phosphorous, and 50% of nitrogen. Grass swales are not as effective in graveled and coarse sandy soils or heavy clay soils. Swales are also effective in removing: dissolved nutrients , floatable materials, human pathogens, increased flow/velocity, organic matter, oil/petroleum materials, other liquids, particulate materials, toxic materials, and water-soluble materials.

- In-line Storm Drainage Treatment Devices

In-line storm drainage treatment devices, or particle separators have been shown to be effective end-of-pipe solutions that often require minimal construction rather than large pipe system overhauls. Numerous inline storm drainage treatment devices were investigated, including BaySaver, Stormceptor®, StormFilter™,

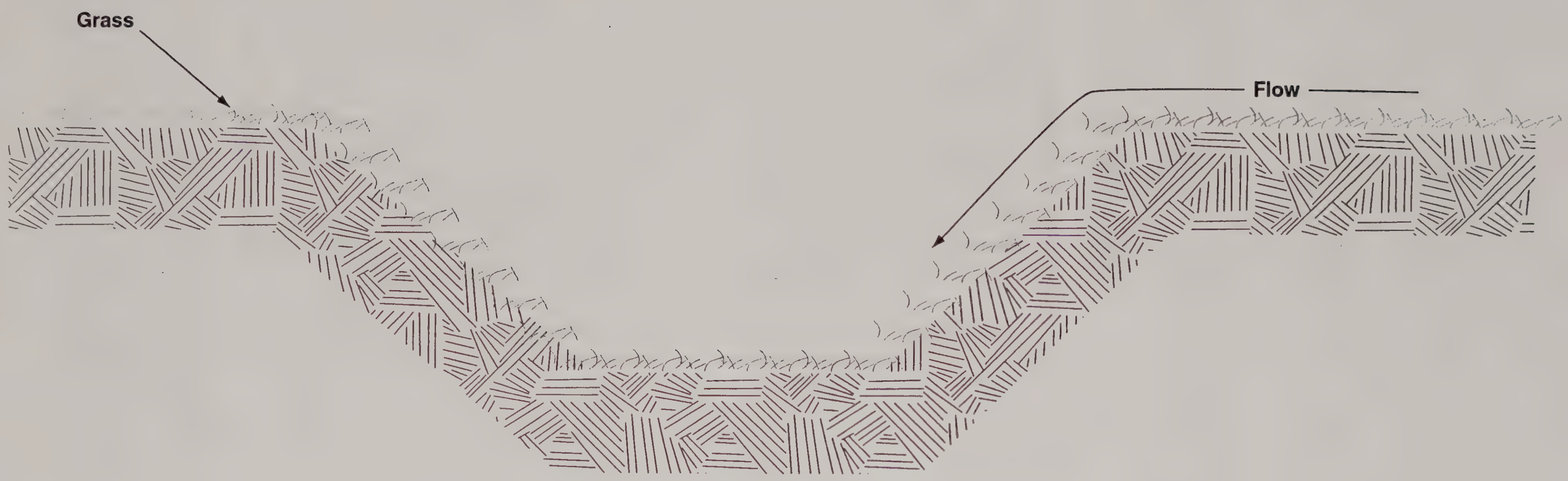


Figure 2-41
Vegetated Swale

StormTreat™ System and Vortechs™. Most of these devices can be installed on existing storm drain systems and are capable of removing oil, sediment and other urban pollutants from stormwater runoff. Existing experience in the watershed has been mixed for these devises. A Pilot Plan to evaluate their application and effectiveness would be useful in order to evaluate the effectiveness of existing devises and to determine the most cost-effective locations to install additional devises.

In addition to the above, the Brookline DPW has installed and operates equipment at it garage that is within the Chestnut Street drainage system to remove oil from the groundwater and to prevent it from entering into Willow Pond.

- In-stream Sedimentation Basins

  In-stream Sedimentation basins were evaluated for feasibility at several points in the Muddy River watershed including the following areas: Willow Pond, Leverett Pond, upstream of Brookline Avenue, downstream of the Netherlands Road, near the Sears Culvert, downstream of the Louis Pasteur bridge, near the Victory Gardens, and downstream of the Agassiz bridge.

  In-stream Sedimentation basins are formed by overdredging (removing additional amounts of sediment from the stream channel) to provide channel capacity for future re-sedimentation. Sedimentation basins are recommended in areas where sediment typically tends to deposit such as near the outlets of storm drains and culverts.

- Sand Filters

  Surface sand filters were also investigated as additional treatment control BMPs in the Muddy River watershed. Typical surface sand filter systems incorporate two basins. Runoff first enters a sedimentation basin (wet or dry) where coarse particles are removed by gravity settling. Water then can flow over a weir or through a riser into the filter basin. The filter bed consists of sand with a gravel and perforated pipe under-drain system to capture the treated water. The surface of the filter bed may be planted with grass. Additional storage volume is provided above the filter bed to increase the volume of water than can be temporarily ponded in the system prior to filtration. This two-basin configuration can help limit premature clogging of the filter bed due to excessive sediment loading. There are several design variations of the simple surface sand filter.

- Underground Vault Sand Filter

  A typical underground vault sand filter design is the "D.C. Sand Filter" which incorporates three chambers. The first chamber and the throat of the second chamber contain a permanent pool of water and function as a sedimentation chamber and an oil and grease and floatable strap, as well as provides for temporary runoff storage. A submerged opening or inverted elbow near the bottom of the dividing wall connects the two chambers. This submerged opening provides a water seal that prevents the transfer of oil and floatables to the second chamber which contains the filter bed. During a storm event, water flows through the opening into the second chamber and onto the filter bed. Additional runoff storage volume is provided above the filter bed. Filtered water is collected by a gravel and perforated pipe under-drain system and flows into the third chamber, which contains a clear well and a connection to the storm drain system. Overflow protection can be provided by placing the filter off-line, or by providing a weir a the top of the wall connecting the filter chamber with the clear well chamber to serve as an overflow. Numerous variations of this "D.C. Sand Filter" exists.

2.5.4 Summary of Recommended BMP Alternatives

A listing and brief description of both the source control and treatment control BMP alternatives that were evaluated for their feasibility and effectiveness in the Muddy River watershed has been provided in the previous sections. As described in the text and Table 2-2, many of the source control BMPs are already being implemented to varying extents in the watershed. These alternatives were evaluated and the following alternatives are recommended for inclusion into the BMP Plan for the Muddy River watershed. Although the selected BMP alternatives are neither totally inclusive nor exclusive, their selection is based on what is currently understood about the watershed, the major contributing pollutant sources, and EPA and DEP guidelines on the effectiveness of individual BMPs and their cumulative effects. These alternatives address the highest sources of sedimentation and contaminants to the Muddy River. Depending on the evaluation of their effectiveness at the end of the Pilot Plan that is recommended in Section 2.5.4.2, refinements could be made in order to either shift the selected BMPs, or to focus attention onto more localized problems. Finally, these and additional BMPs should be encouraged for all entities to develop their own where appropriate consistent with recommendations in Section 5.

2.5.4.1 Recommended Source Control BMPs

Pollutant sources for which source control BMPs would be effective in the Muddy River watershed include:

- sedimentation from street sanding, erosion of banks and park pathways, erosion from the use of "desire lines",
- construction site runoff; nutrients and solids from decaying leaves and litter,
- nutrients, metals and bacteria from urban runoff,and
- nutrients and bacteria from geese.

The implementation of source controls in any environmental condition is the preferred alternative than to treat the problem with more expensive technology. Source control BMPs often offer longer-term return on investments than do the cumulative annual capital, operating, and maintenance costs. Such source control BMPs as public education and the development and enforcement of bylaws and regulations also address a much large audience than do localized treatment BMPs.

In addition, programs to monitor water quality, planted vegetation and the response of the fish and wildlife communities to the environmental enhancements must be implemented. Otherwise, there is no measure by which to assess the cumulative effectiveness nor to make appropriate alterations in the plan.

The source control BMPs that are considered to presently offer the most effectiveness include the following: Improve catch basin cleaning and street sweeping programs

Correct desire lines (BPRD) and Brookline

Address private ways (Brookline)

Maintain restored banks, pathways and uplands (BPRD and Brookline) with particular care and attention to active recreational areas adjacent to water (i.e. Daisy Field).

Eliminate mesh trash barrels

Develop leaf collection programs

Develop plan to enforce "pooper scooper" laws

Develop waterfowl control plan

Local storm water guidelines

Develop programs to monitor water quality, planted vegetation, and fish and wildlife to assess effectiveness of the implemented BMP plans.

2.5.4.2 Recommended Treatment Control BMPs

Many of the treatment control alternatives discussed in 2.5.3 are effective in proper settings. However, as the result of findings in this document, there needs to be further evaluation before they can be designed. Therefore, the development of a computerized Pilot Plan to track the application and retrieval of solids in Brookline is recommended before any further treatment control BMPs are implemented. Treatment control BMPs may be implemented in instances and locations where source control alternatives are not applicable such as the control of solids from large roadways and in-stream sedimentation basins to collect and restrict the migration of solids and associated contaminants from a discharge to down stream areas. Treatment control BMPs may also be implemented in locations where attempts to utilize source control BMPs has not proven effective.

The following selected alternatives were judged suitable in the Muddy River watershed and targeted to the greatest sources of sediment loads.Vegetated treatment swale next to Victory Gardens

Additional particle separators or other treatment control BMPs resulting from the Pilot Plan findings

Particle separators at common low points in MDC system, BWSC drainage at Daisy Field and the Emmanuel College Drain itself.

In-stream sedimentation basins (numerous locations as discussed in 2.5.3)

2.6 Screening of the Project Alternatives and Selection of the Recommended Plans

The project objectives and goals are:

- Provide flood control - Maintain the flood elevation not higher than elevation 15 BCB in the Riverway and to remove other flow restrictions.
- Improve water Quality - Contribute to the attainment of Class B Water Quality Standards in both the Muddy River and the Charles River.
- Enhance Aquatic/Riparian Habitat - Increase the size/volume, quality and diversity of the aquatic and riparian habitat.
- Restore Landscape and Historic Resources - Contribute to the restoration of historic landscape/resources while maintaining the Continuum, and
- Institute Best Management Practices (BMPs) - Reduce pollutant loading and contribute to the attainment of Class B Water Quality Standards in both the Muddy River and the Charles River

The proposed alternatives for achieving each of the objectives were discussed in previous sections and are summarized in the matrix in Table 2-3. The matrix is marked to show where the alternative would achieve any of the project objectives, not just the primary objective for which it was proposed. The recommended alternatives are in bold.

In Section 2.1.2.1 the day lighting alternatives were discussed and screened down to either an engineered channel which was less costly or the historically aligned channel. These are the major subsets for flood control. Under culvert enlargement or replacement discussed in Section 2.1.2.2, there was a single preferred alternatives for each location based on technical or cost reasons. The other sub-alternative for culverts were not brought forward since they are not materially different from the project objective point of view. The modified historical alignment alternatives was selected because it not only met the goal of flood control, but it would improve the historical

Alternatives	Flood Control	Water Quality Improvement	Aquatic/Riparian Habitat Enhancement	Treatment of Landscape and Historic Resources	Best Management Practices (BMPs)
Flood Control					
No Action					
Infrastructure Improvements					
Engineered Channel/culvert enlargement	□				
Historic Alignment/culvert enlargement	□			□	
Modified Historic Alignment/culvert enlargement	□			□	
Dredge Charlesgate Only	□	□	□		
Dredge Channel Through Back Bay Fens	□	□	□		
Increase Upstream Storage					
Flood-Proof Property					
Improve Water Quality					
No Action		○	○		
Eliminate Illegal Sewer Connections*		□	□		
Sewer Separation*		□	□		
Point Source Control*		□	□		
Implement BMPs		□	□		△
Flow Augmentation					
Aeration					
Harvesting of Aquatic Vegetation					
Enhancing Aquatic and Riparian Habitat					
No Action					
Improve Water Quality*		△	□		
Bank to Bank Dredging	□	△	△	□	
Removal of Invasive Vegetation and Planting Wetland Vegetation	□		△	□	
Restoration/Enhancement of Historic Islands			△	△	
Enhancing Fish Spawning Habitat			△		
Restoration of Babbling Brook			△	△	
Treatment of Cultural and Historic Resources					
No Action					
Implementation of the 1990 Emerald Necklace Master Plan*	△	□	△	△	
Primary and Secondary Periods of Significance	△	□	△	△	
Best Management Practices					
No Action					
Source Control Options*	○	□	□		△
Treatment Control Options*		□	□		△

△ Fully Meets Objective □ Partially Meets Objective ○ Addresses some elements of Objective * Part of No Action Alternative

Table 2-3
Alternatives Matrix and Recommended Alternatives

treatment of the river and allow for current uses such as bike and pedestrian paths. Neither dredging alternatives was recommended because the full dredging alternative(included in the alternatives for improving habitat) is recommended alternative.

The fully dredged bank to bank channel alternative is the only alternative that fully enhances the aquatic and riparian habitat. Aquatic and riparian habitat can not be fully enhanced unless the invasives are removed to allow replanting of a diverse habitat. In the dredging alternatives that do not address full bank to bank removal of sediments and invasives the remaining invasives would result in a continued degrading of the habitat.

The conclusion of the flood control alternatives screening is that the natural channel following modified historic shorelines, combined with improved culverts addresses more project objectives and therefore is the recommended project alternative.

The recommended alternatives for improving water quality are: continuing to eliminate illegal sewer connections, continue with sewer separation projects and implementing various point source controls which area actually part of ongoing work and are therefore No Action alternatives. Aeration, flow augmentation, and aquatic weed harvesting were not recommended because they did not contribute any more than would be realized through the dredging and BMP alternatives.

Of the various alternatives for improving aquatic and riparian habitat, the full dredging alternative, removal of invasive species, wetland and riparian vegetation planting and restoring historic islands are the recommended alternatives. The bank to bank dredging of the river, along with *Phragmites* removal would improve water quality reduce invasive species which would allow more diverse wetland planting to thrive and help restore historic conditions along the river, in addition to meeting the objective of flood control . The partial dredging alternatives that were proposed for flood control would not fully achieve the additional project objective of improving water quality and only partially meet the objectives of improving habitat while not improving treatment of historic resources.

The implementation of the 1990 Emerald Necklace Master Plan is recommended to achieve the objective treatment of cultural and historic resources. The treatment plan that would respect the Primary and Secondary Periods of Significance was not endorsed because of the substantial conflicts with the modern land uses that would result from its implementation. The "continuum" treatment plan was decided upon because of its feasibility to implement and its compatibility with present day land uses and environmental laws and regulations. It includes full bank to bank dredging, day lighting of culverts and replacing invasive species with vegetation from Olmsted's species list, thus implementing this plan achieves other project objectives in addition to the primary objective of treatment of cultural and historic resources, and restoration of the Carlton Street footbridge.

Finally, to fulfill the objective of Best Management Practices, it is recommended that various source control and treatment control options discussed in Section 2.5 be implemented. In addition to meeting the BMP objective some of the options would improve water quality, sediment quality and the aquatic and riparian habitat.

3

Section Three

Section 3
Public/Agency Involvement

The City of Boston and the Town of Brookline believe that the successful implementation of the Project is dependent upon open communication with and active involvement of the many faces of the public including: citizens; community groups; environmental associations; educational/cultural institutions; and state and local administrative and regulatory agencies. The project proponents have developed a multi-faceted public involvement program that seeks to:

- Inform and educate the public about all facets of this project, particularly in understanding the benefits and impacts associated with various improvement measures for meeting the multiple project objectives;
- Solicit input and provide opportunities for the public to articulate their concerns and issues about any aspect of the project;
- Thoroughly address and where appropriate document responses to the public's and/or state and local agency issues and concerns;
- Build support, and when possible, consensus on all elements of the project; and
- Foster aggressive public support for additional funding necessary to complete all aspects of the Muddy River Restoration Project.

Section 3 Public/Agency Involvement presents a summary of the specific public/agency involvement and coordination activities that have been completed during the development of the DEIR. Section 3 also presents an outline of the planned public involvement and agency coordination activities that will occur during the remaining phases of the project from completion of the environmental review process, through final design and construction of the project.

3.1 MEPA Requirement for Public Involvement

On April 29, 1999, the Secretary of Environmental Affairs, in his review of the Environmental Notification Form (ENF) for this project issued two Certificates governing the scope and process for the environmental review of the Muddy River Flood Control, Water Quality and Wildlife Enhancement and Historic Preservation Project (the Project). The first Certificate detailed the scope of the environmental impact report. The second Certificate established a Special Review Procedure for public and agency review of the project.[1] [See section 1.3.1 Special Review Procedures for more information]

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[1] Environmental review of projects above a certain size that involve some state agency action is governed by the Massachusetts Environmental Policy Act (MEPA). The MEPA Office is the staff of the Secretary of Environmental Affairs responsible for the implementation of the MEPA environmental review procedures. The MEPA regulations, contained in 301 Code of

The Special Review Procedure included the establishment of a Citizen's Advisory Committee (CAC) to serve as the primary forum for public involvement during the development and implementation of the Project.

3.2 Citizen's Advisory Committee (CAC)

The Citizen's Advisory Committee (CAC) for the Project has been designated by the Secretary as the Emerald Necklace CAC. The Emerald Necklace designation reflects the fact that the Project is the first phase of The Emerald Necklace Environmental Improvements Master Plan as described in the ENF.

The role of the Emerald Necklace CAC is set forth in the second Certificate. The central function of the CAC is to advise the Secretary in his evaluation of the project proponent's proposed means and measures to minimize impacts to the environment while achieving the project's five principal objectives: increase flood control; improve water quality; enhance aquatic/riparian habitat; restore landscape and historic resources; and institute Best Management Practices in the Muddy River System.

The CAC's task, as described in the second Certificate, is to review proposed activities, comment on the feasibility of different approaches and their likely environmental impacts, and assist the proponent in generating and reviewing alternatives which would avoid or minimize damage or impacts to the environment.

The project proponents, the City of Boston and Town of Brookline, and their consultants, are required to provide information and analysis on the Project to enable the CAC to adequately review the project and provide comments to the Secretary. The MEPA regulations also require that the project proponent provide the CAC with a preview of each EIR (draft and final) at least 30 days prior to submitting the document to the Secretary of Environmental Affairs.

3.2.1 Emerald Necklace CAC Membership

In September 1999 the Secretary appointed 29 individuals to serve on the CAC. The Secretary comprised this group of individuals from a recommended list by the City of Boston and individual responses to an advertisement by the Town of Brookline. Many members of the CAC are affiliated with, or represent organizations and community groups that have been leaders on issues concerning the Muddy River or

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Massachusetts Regulations 11.00, provide the details of the review process and procedures. The regulations establish thresholds for review, and establish a two-stage review process marked by the submission of a draft and final environmental impact report by the project proponent. The Special Review Procedure provision in the MEPA regulations provides the Secretary and proponents with the flexibility to structure alternative procedures for reviewing especially complex projects, for which the typical MEPA review may not be fully appropriate.

Emerald Necklace park systems, and/or issues in the adjacent communities in Boston and Brookline.

Emerald Necklace Citizens Advisory Committee

Name	Affiliation
Kathy Baskin[2]	Charles River Watershed Association
Charles Alan Birnbaum	National Park Service
Kate Bowditch[3]	Brookline Conservation Commission
Kelly Brilliant[4]	The Fenway Alliance
Ed Burke[5]	Restore Olmsted's Waterway Coalition
Isabella M. Callanan	Friends of the Muddy River
Suzanne Comtois	Fenway Community Development Corporation
Christine Cooper	Jamaica Pond Project
Edward Cutler	Brookline Resident
Pamela DiBona[6]	Charles River Watershed Association
Margaret Dyson[7]	Historic Massachusetts, Inc.
Frances Allou Gershwin	
Irene Gillis[8]	Restore Olmsted's Waterway Coalition
Alan Goodman	The Abbey Group
George Hagerty	Fenway Studios, Inc.
June Hatfield	Boston Greenspace Alliance
Richard Heath[9]	Emerald Necklace Woodlands Program
Gary R. Hilderbrand	Reed Hilderbrand Associates, Inc.
Adam Kahn[10]	Brookline Conservation Commission
Frances J. Kemp	Fenway Civic Association, Friends of the Muddy River, Fenway Resident
John Leahy	Northeastern University Student
Arleyn A. Levee	National Association for Olmsted Parks
John A. Martin[11]	Emerald Necklace Conservancy
Arlene Mattison[12]	Emerald Necklace Conservancy

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[2] Ms. Baskin replaced Ms. Penniman in March 2001 as the representative from the Charles River Watershed Association.

[3] Ms. Bowditch resigned from the CAC in June 2000.

[4] Ms. Brilliant replaced Mr. Mentag in August 2001 as the representative from The Fenway Alliance.

[5] Mr. Burke replaced Ms. Gillis in 2000 as the representative for Restore Olmsted's Waterway Coalition.

[6] Ms. DiBona resigned from the CAC in July 2000.

[7] Ms. Dyson resigned from the CAC in October 2001 to take the place of Ms. Fran Beatty of Boston Parks.

[8] Ms. Gillis resigned from the CAC in March 2001.

[9] Mr. Heath resigned from the CAC in September 2001.

[10] Mr. Kahn replaced Ms. Bowditch in July 2000 as the representative from the Brookline Conservation Commission.

[11] Mr. Martin resigned from the CAC in April 2001.

Hugh Mattison	Friends of Leverett Pond
Lauren Meier	
Paul Mentag[13]	The Fenway Alliance
M. Crain Penniman[14]	Charles River Watershed Association
Jane Walker Pfister[15]	Brookline Resident
George Proakis	Boston Resident
Marion Sabal	Fenway Garden Society
Roscoe Sandlin[16]	Fenway Community Development Corporation
Joyce Starner[17]	Symphony United Neighbors
Fredericka Veikley	Fenway Civic Association
Eileen Woodford	National Parks & Conservation Association

Meetings of the CAC are facilitated by the Massachusetts Office of Dispute Resolution (MODR). The first meeting of the CAC was held on September 29, 1999 with Jane Wells as the CAC Facilitator. During meetings held between October 1999 and July 2000 Ms. Fredie Kay served as the CAC Facilitator. During meetings held between July 2000 and June 2001 Ms. Susan Jeghelian from the MODR served as the CAC Facilitator. Ms. Jane Wells has been the CAC Facilitator since June 2001.

3.2.2 CAC Meetings

As of November 14, 2001, the Emerald Necklace CAC has met 31 times with the project proponents, City of Boston and Town of Brookline and their consultants, beginning in September 1999. Listed below is the schedule of CAC meetings to date, followed by a brief summary of the topics addressed and issues raised at each meeting.

Meeting Date	Meeting Topic
September 29, 1999	Introductions, Overview of Muddy River Park System
October 26, 1999	Historical Summary of Muddy River System Master Plans
February 28, 2000	Overview of MEPA and Role of CAC, Introduction of Consultant Team, Project Overview
March 30, 2000	Alternatives for Evaluation
May 16, 2000	Best Management Practices (BMP)
June 13, 2000	Wildlife Habitat Characteristics
July 17, 2000	Historic Resources
August 22, 2000	Staging Areas, Pedestrian & Traffic Issues
September 19, 2000	Culvert/Open Channel/Dredge/Disposal
September 28, 2000	Sediment Characterization/Disposal

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[12] Ms. Mattison replaced Mr. Martin in 2001 as the representative for the Emerald Necklace Conservancy.

[13] Mr. Mentag resigned from the CAC in July 2001.

[14] Ms. Penniman replaced Ms. DiBona who resigned from the CAC in July 2000. Ms. Penniman resigned from the CAC in March 2001.

[15] Ms. Pfister resigned from the CAC in October 2001.

[16] Mr. Sandlin resigned from the CAC in September 2000.

[17] Ms. Starner resigned from the CAC in November 2001.

October 23, 2000	Alternatives Analysis
October 30, 2000	Best Management Practices Plan
November 15, 2000	Mitigation Measures
January 25, 2001	Overview of Project Elements and Construction Cost Estimate
February 26, 2001	Construction Cost Estimate (continue discussion) and Overview of Draft Environmental Impact Report (DEIR) Outline
March 14, 2001	Discussion of How the CAC will Review the DEIR
April 23, May 2 May 7, May 16, May 21 May 30, June 4, June 13 June 20, June 25, July 10, and July 18, 2001	Review of DEIR (12 meetings)
October 3, 2001	Project Update and Discussion with Laura Rome, MEPA Office
October 29, 2001	Update on Management & Maintenance
November 14, 2001	Discussion of Revised Draft Park Maintenance Plan and How to Review the 'Official' DEIR

All meeting correspondence (notices, agendas, etc.), consultant team presentations and handouts, and meeting summaries for each CAC meeting that are summarized below are included in Appendix M - CAC and General Public Meeting Materials.

Introductions, Overview of the Muddy River System (September 29, 1999)
The first meeting of the CAC was introductory in nature. Fredie Kay of the MODR introduced the mission of the MODR and explained the role of the CAC Facilitator. Jane Wells, acting as the CAC Facilitator, explained the CAC procedures and meeting protocol, and then requested that the CAC members introduce themselves and state their expectations for the project. The project proponents, specifically the Boston Parks and Recreation Department and the Town of Brookline, presented an overview of the Muddy River System including the river and the adjacent parkland.

Historical Summary of Muddy River Master Plans (October 26, 1999)
Dr. Charles Beveridge, a renowned historian and expert on the work of Frederick Law Olmsted, presented a historical summary of Muddy River master plans beginning with Olmsted's initial vision and plan for the Muddy River at towards the end of the 19th century through the development of the Emerald Necklace Master Plan that was completed in 1990. No meeting summary was produced for this meeting.

Overview of MEPA and Role of CAC, Introduction of Consultant Team, Project Overview (February 28, 2000)
Jay Wickersham, Director of the MEPA Office presented an overview of the Massachusetts Environmental Policy Act (MEPA) and the regulations that guide public and agency review of projects with environmental impacts above certain

threshold limits. Specifically, Mr. Wickersham discussed the Secretary's Certificate on the ENF that established the Special Review Procedure and development of a Citizen's Advisory Committee (CAC) to review and provide input on the project and to the Secretary.

Fran Beatty, Senior Landscape Architect from the Boston Parks and Recreation Department, introduced the consultant team. Ms. Beatty reviewed the role of Parsons Brinckerhoff Quade and Douglas, Inc., the Program Manager for the Project; and the design consultant team, lead by Camp Dresser & McKee Inc. (CDM) supported by Jason M. Cortell and Associates, Inc., Pressley and Associates, Inc., and Vanasse, Hangen, Brustlin, Inc. Bruce Conklin, P.E., Vice President, CDM, and Project Manager presented a brief overview of the project and identified proposed CAC meeting topics to guide the CAC's review and input on the project during the development of the Draft Environmental Impact Report (DEIR).

Alternatives for Evaluation (March 30, 2000)
Bruce Conklin and Carlton Noyes, from Jason M. Cortell and Associates Inc., presented a detailed listing of project alternatives that will be considered and evaluated. The CDM team developed a list of alternatives, beginning with those identified in the ENF, to meet the project objectives. After review of the alternatives presented, the CAC identified several additional alternatives to meet the project objectives for the CDM team to consider and evaluate.

The project alternatives identified in the ENF, those developed by the CDM team, and those recommended by the CAC complete the list of all project alternatives that would be evaluated during the DEIR.

Best Management Practices (May 16, 2000)
David Noonan, P.E., Vice President, CDM, and Carl Noyes presented an overview of Best Management Practices (BMPs), how the CDM team defines them, their importance to the success of the project and responsible entities for implementation of BMPs. BMPs are essential to ensuring that the life cycle benefits of the proposed improvements are maximized, specifically the BMPs are focused on reducing the re-sedimentation rates to the Muddy River.

Mr. Noonan explained that the CDM team conducted an inventory of BMPs in the Muddy River watershed; reviewed and presented a summary of existing BMP programs that are being implemented by the various local and state entities with jurisdiction in the Muddy River system; and compared the existing programs with a "model" BMP program. Mr. Noonan also identified the process which the CDM team will utilize to further analyze existing BMPs, identify and review alternative BMP measures, and develop a comprehensive Maintenance Management Plan to ensure the long-term implementation of BMPs by the applicable public entities.

Wildlife Habitat Characteristics (June 13, 2000)
Bruce Conklin and Paul Lelito, Principal, LEC Environmental Consultants, Inc., presented an overview of the wildlife characteristics in the Muddy River system. The purpose of the presentation was to: 1) obtain CAC views on suggested habitat improvement concepts to guide development of habitat improvement program by river segment; and 2) begin discussions on the interrelationship between habitat improvement and historical treatment.

Mr. Lelito presented a summary of the baseline data he collected on the wildlife habitat and current wildlife use along the Emerald Necklace. He noted that the baseline data included observation of mammals, avian species, fish, amphibians and reptiles, as well as vegetative characteristics. Each link along the Emerald Necklace was assessed for wildlife habitat, *(i.e.* Olmsted Park, The Riverway, and the Back Bay Fens). Vegetation was identified with emphasis on structural heterogeneity of the plant communities, i.e. ground (herbaceous), shrub, and tree canopy cover.

The speakers concluded that in order to enhance habitat the biodiversity of the plant community must be increased and that removal of invasive monoculture species is a significant component of increasing biodiversity. By removing the monoculture invasive species both the "provide flood control" and "enhance aquatic/riparian habitat" objectives of the Project could be fulfilled.

At the conclusion of this meeting, the general response of the CAC was that there is a need to increase biodiversity in the park, including replacement of invasive monoculture species. The CAC planned to revisit the biodiversity issue after acquiring a more complete understanding of the application of the proposed habitat improvement in conjunction with the proposals for the historical treatment of the park.

Historic Resources (July 17, 2000)
Bruce Conklin, Dr. Charles Beveridge, Historian on Olmsted Papers, and Marion Pressley, FALSA, President, Pressley Associates, Inc. made a presentation on historical landscape resources in the Muddy River system. The purpose of the presentation was to: 1) discuss the goals of historic treatment and habitat restoration; 2) inform the CAC of the preservation planning process that will result in development of an historic resource treatment plan; 3) obtain CAC views on the compatibility of historic treatment and habitat restoration.

Dr. Beveridge and Ms. Pressley presented an overview of the historic resource investigation they conducted for this project. Dr. Beveridge reviewed the resources that are available to the project team, including original notes and plans of Frederick Law Olmsted and other landscape architects who have worked on the Emerald Necklace. Some of the resources they discovered in their research were never before available or used in previous planning efforts for the Muddy River or Emerald Necklace Systems.

The CDM project team prompted the CAC to provide specific input or affirmation on the direction the team is heading regarding the treatment of historic resources. In response, the CAC developed the following:

CAC Statement on Wildlife Habitat and Historic Landscape Treatment
The CAC agrees that the wildlife habitat and historic landscape treatment planning for the EIR planning should be guided by the 1990 Master Plan augmented as follows:

- *Include new information obtained by the consultant team, CAC and others;*
- *Incorporate subsequent wetland and historic resource regulations;*
- *Include removal of invasive species; and*
- *Include other necessary actions to enhance the compatibility of biodiversity, historic preservation and sustainability.*

Staging Areas, Pedestrian & Traffic Issues (August 22, 2000)
David Noonan, James Winkler, P.E., Design Engineer at CDM, and Joseph Wanat, P.E., Transportation Engineer at VHB, presented on staging areas, pedestrian and traffic issues. The purpose of the meeting was to identify and solicit CAC comment on proposed staging areas that could be used during construction of the Project.

At this point in the project the project team was evaluating alternative construction methodologies. Each of the alternative methodologies have different staging area requirements. Some construction methodologies may require more staging areas than others, while some methodologies also may require larger staging areas, and for a longer duration than other construction alternatives. Therefore, CAC feedback on the proposed staging areas was important to the evaluation of the construction methodologies.

Pedestrian and traffic impacts exist for each staging area. Review of these impacts is important because these impacts most directly affect users of the Muddy River parkland areas and other areas adjacent to proposed staging locations.

Based on the CDM team presentation and CAC member comment on staging area locations and their impacts, the CAC members present agreed upon the following statements on staging areas and dredging construction methodologies.

CAC Statement on Evaluation Criteria for Staging Area Selection
The CAC supports the use of the following evaluation criteria that are used in the project design consultant's analysis of dredging alternatives and potential staging area locations (presented in alphabetical order):

- *Bank disturbance*
- *Bridge and other height constraints*
- *Construction related truck traffic*
- *Ecological impacts*
- *Habitat impacts*
- *Historic resource impacts*
- *Neighborhood traffic impacts*
- *Odors and noise impacts*

Park use impacts
Pedestrian circulation

CAC Statement on Staging Area Use
The CAC recognizes that staging areas are needed to enable and support construction of Muddy River improvements. The CAC understands the number of staging areas needed depends on the improvements to be constructed and the dredging alternative utilized. The CAC also requests that the fewest possible staging areas be used for the shortest duration feasible. To this end, the CAC also supports the use of hydraulic dredging where dredging is necessary to minimize impacts on banks, shorten staging area use, and to control exposure to sediments.

CAC Statement on Selection and Evaluation of Staging Areas
The CAC supports the evaluation and analysis of the following locations, one or more of which could potentially be used as a staging area during construction of Muddy River improvements.

1. *Charlesgate*
2. *Agassiz Road*
3. *Duck House*
4. *Lagoon (Jersey Street)*
5. *Clemente Field*
6. *Evans Way Park*
7. *Fens at Louis Pasteur*
8. *Former Sears Parking Lot*
9. *Netherlands Road*
10. *Daisy Field*
11. *Former MDC Kelly Rink*

The CAC, at this time, does not specifically endorse the use of any of the above referenced locations for use as a staging area until it reviews the complete impact evaluation on each site that will be presented in the Draft Environmental Impact Report.

In addition, based on the previous consultant team presentation on project alternatives evaluation in March 2000, and a review of the staging area requirements and impacts for specific construction technologies, the CAC expressed its support for the hydraulic dredging technology for the removal of sediments in the river. The CAC developed the following statement to affirm its support for hydraulic dredging.

CAC Statement on Dredging Method Selection
The CAC recommends that hydraulic dredging is the preferred alternative with the exception of invasive species.

Culvert/Open Channel/Dredge/Disposal (September 19, 2000)
Bruce Conklin presented on the culvert, open channel, dredge and waste disposal alternatives. The objectives of the presentation were to: 1) present the hydraulic basis

for drainage improvements; 2) review drainage improvement alternatives by river segment; 3) present a summary evaluation of the advantages and disadvantages of the alternatives; and 4) present dredging cross sections to better illustrate post-dredge river profiles.

Mr. Conklin then presented the alternatives that have been identified and evaluated for culvert and open channel options at five sites (Riverway culvert, Former Sears Lot, Brookline Avenue, Upstream of Fens Bridge and Fens Bridge) along the river.

Sediment Characterization/Disposal (September 28, 2000)
The focus of this meeting was a presentation on sediment characterization, dredging, disposal of sediments and invasive species removal. Bruce Conklin, CDM's Project Manager, conducted the presentation which focused on: 1) a summary of sediment disposal options; 2) a review of the sediment sampling results; and 3) a discussion of sediment handling issues. Joseph Wanat, Transportation Engineer from VHB, presented the proposed truck routes from the staging areas to the major thoroughfares, i.e. I-93, I-90 or Route 9. Jim Winkler, Design Engineer for CDM, presented a review of the proposed *Phragmites* removal operation.

Also discussed was the opportunity for the CAC to take a field tour of the project area from Wards Pond to Charlesgate. The CAC informally expressed support of the tour, which was held October 13, 2000.

Alternatives Analysis (October 23, 2000)
The alternatives analysis focused on a summary of all project alternatives considered, a summary of the impacts associated with each project alternative, and the project proponent's recommended project alternatives. Project alternatives were organized by project objective within each segment of the river.

Best Management Practices Plan (October 30, 2000)
The presentation of the alternatives evaluation was completed at the October 23, 2000 CAC meeting. This meeting focused on a follow-up presentation on best management practices (BMP) that was conducted by David Noonan from CDM. The performance goal regarding BMP measures is to prevent to the extent possible and then minimize the re-sedimentation of the Muddy River and extend the life cycle benefits of the improvements that will be constructed.

The CAC emphasized the imperative need for a comprehensive BMP program that addresses source control and clearly delineates roles and responsibilities for implementation of BMPs by the applicable public agencies with jurisdiction in the Muddy River system.

Mitigation Measures (November 15, 2000)
At this meeting, Bruce Conklin presented an overview of specific mitigation measures that would be implemented to lessen the environmental impacts of the Project. The presentation did not highlight all of the mitigation measures that would be incorporated into the construction phase of the project but focused on the

approximately twenty most significant measures that would be implemented during construction.

Overview of Project Elements and Construction Cost Estimate (January 25, 2001)
Bruce Conklin presented the estimated construction cost of the proposed project. The proposed project elements were described along with assumptions in preparing the estimated construction cost. Inflation allowances and contingencies included in the estimate were also discussed.

Construction Cost Estimate (continue discussion) and Overview of DEIR Outline (February 26, 2001)
Bruce Conklin summarized the project status and answered questions concerning capital costs, BMP costs, dredging costs and annual maintenance costs. Other issues of discussion included a management and maintenance team for the Emerald Necklace, replacement or mitigation planting and the determination of potential hazardous sediment. The outline of the Draft EIR was reviewed.

Discussion of How the CAC will Review the DEIR (March 14, 2001)
This meeting was used to discuss and plan the review of the DEIR anticipated to be submitted April 23, 2001. The CAC will be reviewing the "pre-filing DEIR" during the spring of 2001 and providing comments to be incorporated in the "filing DEIR". The CAC will also have the opportunity to comment on the "filing DEIR" during the normal review period.

Selecting between reviewing the DEIR by "MEPA approach"(or by chapter) or by "major topics" the CAC chose to review by "major Topics". Nine topic were selected starting with the Vision Statement/Executive Summary. These topics and one open (if needed) be the subject of 10 planned meetings.

Logistics for recording the meeting and preparing comments were discussed and decisions were made to keep "red-time" notes; prepare a standard list of questions; create a "parking lot' for issues at later meeting; and have members sign up to prepare topic comments.

Draft Environmental Impact Report (DEIR) Review – #1: Executive Summary & Vision Statement (April 23, 2001); #2: Project Alternatives (May 2, 2001); #3 Project Description/Preferred Alternative (May 7, 2001); #4 Project Impacts & Mitigation (May 16, 2001); #5 Best Management Practices (May 21, 2001); #6 Management & Maintenance Plan (May 30, 2001); #7 Management and Maintenance (June 4, 2001); #8 Project Funding (June 13, 2001); #9 Miscellaneous Topics (June 20, 2001); #10 Miscellaneous Topics and Executive Summary/Vision Statement (June 25, 2001); # 11 Review of Vision Statement, CAC Comment Summary Letter and Scope for Management & Maintenance Consultant (July 10, 2001); Management & Maintenance Plan – Meeting with Tim Marshall, ETM Associates (July 18, 2001)
At the proceeding 12 meetings, the April 2001 version of the DEIR was discussed and a letter was developed with comments on the DEIR. As the meeting topics listed

show, the first 11 meetings were held on specific topics, while the last meeting was held for as a project update. The comment letter is attached as part of Appendix M – CAC and General Public Meeting Materials.

Project Update and Discussion with Laura Rome, MEPA Office (October 3, 2001)
This meeting was held to provide an update on the project and to discuss the level of maintenance required for the project.

Update on Management & Maintenance (October 29, 2001)
The discussion of the consultants' work on management and maintenance was continued at this meeting. The Park Maintenance Plan provided by Tim Marshall and the Park Management Models provided by Clarissa Rowe were distributed to the CAC members and comments were discussed.

Discussion of Revised Draft Park Maintenance Plan and How to Review the 'official' DEIR (November 14, 2001)
This meeting was held to discuss the consultant's work on the second draft Park Maintenance Plan and to discuss the review process for the DEIR. The CAC will comment on the second draft of the Park Maintenance Plan in the same format used for commenting on the DEIR. The DEIR is scheduled to be submitted in December, 2001.

A site visit was held for the CAC on October 13, 2000 as an opportunity to review project alternative recommendations in the field.

3.3 Technical Advisory Group

The Technical Advisory Group includes members from Boston Parks & Recreation Department, Town of Brookline, EOEA/DEM, MEMA, MDC, ENC and Fenway Alliance. Jack Malone of Northeastern University is chairperson of the group.

The group initiated prior to the selection of consultants for the DEIR development, and through spring 2001 had been meeting nearly every week. The group has been meeting monthly since the spring of 2001. The purpose of the group is to advice the project proponents on technical and regulatory aspects of the project during its development.

3.4 Public Participation

The success of the Project is dependent upon productive communication between the proponents and the public. This communication includes informing, educating, soliciting input from, addressing questions of and building support of the Project from the public.

Public Information Meeting (November 8, 2000)
The agenda and presentation material for the Public Information Meeting on November 8, 2000 are included in Appendix M – CAC and General Public Meeting Materials. The purpose of this meeting was to present an overview of the Project, a

summary of the alternatives evaluated, and a review of the recommendations. The meeting emphasized the high priority of the Project and also the importance of the public participation process. Laura Rome presented an overview of the environmental review process prescribed under MEPA and emphasized that the scope of work for the DEIR has been widely distributed and is available to the public. Marion Pressley presented an overview of the history of the Emerald Necklace and the development of the Muddy River and the adjacent parklands. Bruce Conklin then summarized the Project's objectives, the process of developing alternatives and the recommended project that will be presented in the DEIR. An extensive question/answer period concluded the meeting.

A second public meeting was held on December 2, 2000 for the Fenway Garden Society, which repeated the presentation of the November 8, 2000 public meeting.

3.5 Agency Coordination

The complexity of this project necessitates coordination of many proponents involved with the scope preparation. Proponents from multiple disciplines and multiple jurisdictions will review the scope of the Project. Integration between the multiple agencies is complex, but ultimately the Project's successful implementation is dependent on the multiple views and comments.

3.5.1 Agency Outreach

Many meetings have been held with multiple agencies to discuss potential issues arising from the Project.

Meeting with Town of Brookline to Review Staging Areas (August 10, 2000)
This meeting was held to discuss potential staging areas to be used during construction, specifically in the Netherlands Road area. Netherlands Road falls under jurisdiction of the Parks and Recreation Department, and that the Department may have some concerns with the staging areas.

The Town was confirmed that an evaluation on traffic impact on both Brookline Avenue and The River`way would be completed. This traffic evaluation will be completed by VHB.

Meeting with MDC to Review Alternate Truck Traffic Routes (September 13, 2000)
Potential staging areas for the project were discussed, specifically the Charlesgate area under the Bowker Overpass. The MDC is concerned about the restoration of the area and wants to see any plans for redesign of the area if planned. They could potentially contribute to reconstruction of the area.

Regional traffic routes from the staging areas proposed for the project were discussed with MDC transportation officials. The principal routes out of the area would be to I –93 via Massachusetts Avenue and Route 9. Two of the most important comments were that there needs to be an accommodation for truck staging that is not on the roadway and there will be a need for permits to operate on the parkways.

Meeting with Boston Conservation Commission (September 20, 2000)
This meeting was held to present the wetland mapping delineation to the Boston Conservation Commission for consideration. The mapping was prepared with the knowledge and advice of the Executive Director and reflected the limits of resource areas for the project. The importance of submitting the information was to get a predetermination of the resource areas that the project will impact. The delineation was approved.

Meeting with Brookline Conservation Commission (September 26, 2000)
This meeting was held to present the wetland mapping delineation for consideration by the Brookline Conservation Commission. The mapping was prepared with the knowledge and advice of the Executive Director and reflected the limits of resource areas for the project. The importance of submitting the information was to get a predetermination of the resource areas that the project will impact. The delineation was approved.

Meeting with BTD to Review Alternate Truck Traffic Routes (September 27, 2000)
Staging areas for the project were discussed in this meeting. The BTD is concerned about the truck staging around the areas of the staging sites. They want some level of control during development of the specifications concerning the contractor's use of adjacent properties.

Regional traffic routes from the staging areas proposed for the project were discussed with BTD transportation officials. The principal routes out of the area would be to I -93 via Massachusetts Avenue and Route 9. No specific problems were identified with the routes selected.

Meeting with Peter Ditto (Brookline Engineer) to Review Alternate Truck Traffic Routes (October 16, 2000)
The purpose of this meeting was similar to the September 27, 2000 meeting held with the BTD. Staging areas for the project were discussed. The Town of Brookline is also concerned about the truck staging around the areas of the staging sites. They want some level of control during development of the specifications concerning the contractor's use of adjacent properties.

Regional traffic routes from the staging areas proposed for the project were discussed with Peter Ditto and other transportation officials. The principal routes out of the area would be to I -93 via Massachusetts Avenue and Route 9. The Route 9 area affects the Town of Brookline. No specific problems were identified with the routes selected.

Meeting with MDC to Discuss Best Management Practices for The Riverway and The Jamaicaway (September 27, 2000)
This meeting was an informational session in which CDM discuss the responsibilities of the MDC with respect to maintenance of the roadways. The MDC is responsible for the care and control of the roadways, such as sweeping streets, cleaning catch basins,

resurfacing pavement and repairing curbs. The MDC cannot implement any capital projects on The Riverway, the City of Boston must perform any capital projects. Some of the responsibilities of the MDC cannot be performed, mostly due to a lack of budget. This is the reason The Riverway has several clogged catch basins.

Meeting with DEP to Discuss the Wetland Protection Act (September 19, 2001)
A meeting at DEP was held to review the Wetlands Protection Act issues with staff before the DEIR was submitted. Issues concerning dredge disposal, sedimentation basins and wetland habitat replacement were discussed.

Meeting with MEPA to Discuss Park Maintenance (September 20, 2001)
A site meeting with MEPA officials (Laura Rome and Jay Wickersham) was held to review the work in resource areas by BPRD staff for park maintenance. A working relationship was discussed on how to better coordinate this work so that Notices of Project Change are not required for routine maintenance work.

Meeting with ACOE, DEM, BLC and MHC to Discuss the Status of the DEIR (October 26, 2001)
A meeting at Boston City Hall was held with US Army Corps of Engineers, DEM, Boston Landmarks Commission and Massachusetts Historic Commission to discuss current status of the DEIR and specific historic impacts anticipated for the project.

3.5.2 Pre-Application Review Committee

The City of Boston and Town of Brookline committed early in the project to the development of a Pre-Application Review Committee (PRC) as allowed under regulation. The purpose of a PRC is to improve the flow of information to the permitting agencies on large complex projects. This approach enables the agencies to provide early comments on the EIR and permitting approach with the goal of streamlining the permitting process. A letter was prepared and sent on March 27, 2000 inviting the relevant agencies to participate in the PRC with the first meeting scheduled for April 25, 2000. Members of the committee are presented below.

Pre-Application Review Committee

Laura Rome	EOEA MEPA Unit
Richard McGuiness[18]	Boston Conservation Commission
Tim Famulare[19]	Boston Conservation Commission
Erin Chute[20]	Brookline Conservation Commission
Thomas Brady[21]	Brookline Conservation Commission
John P. Sullivan, Jr.	Boston Water & Sewer Commission

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[18] Mr. McGuiness resigned from the Boston Conservation Commission in February 2001.

[19] Mr. Famulare replaced Mr. McGuiness in February 2001 as the representative from the Boston Conservation Commission.

[20] Ms. Chute resigned from the PRC in February 2001.

[21] Mr. Brady replaced Ms. Chute in February 2001 as the representative from the Brookline Conservation Commission.

Steven G. Lipman	DEP Special Projects Coordinator
Judith Perry[22]	DEP Main Office, Water Quality Certification
Yvonne Unger	DEP Main Office Water Quality Certification
Rachael Freed	DEP Northeast Regional Office, Wetlands and Waterways
David Slagle	DEP Northeast Regional Office, Wetlands and Waterways
Richard Thibedeau	Department of Environmental Management
Judith B. McDonough	Massachusetts Historical Commission
Greg Penta	US Army Corps of Engineers
Jane Downing[23]	US Environmental Protection Agency
David Webster	US Environmental Protection Agency
Jeffery A. Bean	FEMA
Richard Keller	Massachusetts Division of Fisheries and Wildlife
Phillip Morrison	US Fish and Wildlife Service
Peter D. Colosi	National Marine Fisheries Service

Richard Keller of the Massachusetts Division of Fisheries and Wildlife sent a response that he could not attend due to conflicting assignments on other resource teams, however any specific concerns could be directed to him.

Three PRC meetings were held as described below.

3.5.2.1 PRC Meeting #1 (April 25, 2000)

The agenda, meeting notes and presentation material for the first PRC meeting on April 25, 2000 are included in Appendix M – CAC and General Public Meeting Materials. Generally, the meeting presented the overview of the project, the organization of the consultants preparing the work and the anticipated work elements to follow. There was a presentation of the permitting sequence, and sampling plans for water and sediment quality. These sampling plans were presented to obtain early comments on the sampling programs contemplated for the project. Finally a discussion was held about conducting this project as a "limited project" under 310 CMR 10.53.

Future meetings for the PRC were discussed and it was decided that one other meeting to review wetland issues as they relate to project work elements would be sufficient. The meeting may take the form of a field visit followed by working sessions.

3.5.2.2 PRC Meeting #2 (October 20, 2000)

A second PRC meeting was held on October 20, 2000. The meeting was held as a field visit to review the project alternatives being considered in the DEIR , the wetlands delineations, the wildlife habitat study, anticipated bank disturbance and restoration, and to discuss the proposed dredging methodology. Handouts were provided on a limited basis showing the project alternatives presented to the CAC, the hydraulic gradelines from the EOEA study and preliminary sediment quality maps. Copies are not included in the appendix since they are included in other portions of this document.

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[22] Mr. Perry left DEP and was replaced by Ms. Unger.
[23] Ms. Downing was replaced by Mr. Webster of EPA.

There did not seem to be major concerns with the project elements in the Back Bay Fens area such as removing *Phragmites* for flood control and habitat enhancement. The DEP expressed reservations about the bank disturbance in the area of The Riverway because they did not see the overriding justification for this work. DEP expects that the DEIR will present justification under the Wetlands Protection Act for work in each area of the project where wetlands and banks are anticipated to be disturbed. The DEP also expressed some reservations about the concept of dredging sedimentation basins in the river as part of the Best Management Practices.

3.5.2.3 PRC Meeting #3 (December 7, 2000)

A meeting was held at Boston City Hall to discuss the historical and landmarks permitting issues of the project with respective agencies. A presentation of the anticipated project elements was made to the attendees to familiarize them with the proponents' plans and how they may be affected by the various historical and landmark regulations. The attendees requested that a written description of the project be provided for their use before the permitting process begins.

A discussion followed of how some of the project elements are affected by the environmental regulations and historical regulations. The participants were encouraged to participate in the Pre-Application Review Committee process to help work through these conflicts prior to the MEPA process.

No additional PRC meetings were discussed. Since the PRC includes many regulatory groups, the material provided to PRC members is included in Appendix K Regulatory and Agency Correspondence.

3.5.2.4 PRC Meeting #4 (March 14, 2001)

A PRC meeting was held jointly with the TAG meeting to review elements of the draft EIR that was being prepared for review prior to submittal to the CAC.

Project elements in each segment of the project area were discussed along with the corresponding project objective the elements addressed. Regulatory staff reviewed justification of project elements and how these were to be documented in the DEIR. Environmental regulators and historic regulators discussed elements on the project such as bank stabilization in the Riverway and how the elements would meet each of the regulatory goals.

3.6 Public Participation During Development of Final Environmental Impact Report

As of November 14, 2001, the CAC has held 31 meetings during the DEIR/preliminary design process.

The CAC will continue to hold meetings during the development of the FEIR. The number of meetings during the development of the FEIR will depend on the issues to be addressed as described in the DEIR Certificate. As with the development and review of the DEIR, there will be topic meetings during the development of the FEIR, plus a CAC review period of the FEIR.

There have been two public meetings held during development of the DEIR. Including those mandated by MEPA, it is anticipated additional public meetings may be held as public reviews for the DEIR and subsequent FEIR.

3.7 Public Participation During Design

It is anticipated that the CAC will hold up to four meetings during the design phase of the project. There will be at least one CAC meeting to discuss the Charlesgate final design.

Public meetings will be held during the design phase of the project.

3.8 Public Participation During Construction

It is anticipated that the CAC will hold meetings and/or site visits during the construction phase of the project (including construction of Charlesgate).

Public meetings may be held as necessary during the construction phase of the project. Information on the status of construction will be made available to the public on an ongoing basis and periodically updated.

Depending on the extent of issues associated with any phase of this project, some of the above described meetings and/or site visits will be combined.

4

Section Four

Section 4
Existing Conditions

This section of the EIR/EA contains descriptions of the existing environment in each of the Project areas (Charlesgate, Back Bay Fens, Riverway, Leverett Pond, Willow Pond, and Wards Pond). The discussions are presented in this manner intentionally, albeit redundant in some respects, to facilitate understanding of the environmental conditions within a discrete project area without having to read the entire section.

4.1 Study Area Description

The Muddy River watershed is located within the City of Boston and the Town of Brookline, Massachusetts. A small part of the watershed is located in Newton.

The Muddy River Project area is contained within the historic park system that is known as the Emerald Necklace. The Emerald Necklace consists of a series of parks that was planned by Frederick Law Olmsted to extend from the Boston Public Gardens and along Commonwealth Avenue, encompassing the Muddy River through the Arnold Arboretum and Franklin Park to the South Boston beaches, and culminating at Castle Island. The link from Franklin Park through Dorchester was never constructed. A circa 1897 plan (see Figure 4-1) depicts the layout of the present-day Emerald Necklace encompasses the following park areas:

- Charlesgate
- Back Bay Fens
- Riverway
- Olmsted Park (Leverett Pond, Willow Pond, Wards Pond, Jamaica Pond)
- Arnold Arboretum
- Franklin Park

The Emerald Necklace and its components are listed on the National Register of Historic Sites and ocated near several other districts, individual structures, and institutions that also are listed on the National Register in addition to being designated as landmarks by the Boston Landmarks Commission. Tables 4-1 and 4-2 summarize the historic resources near and within the Emerald Necklace.

The Phase I Muddy River Flood Control, Water Quality and Habitat Enhancement and Historic Preservation Project includes the following areas within the Emerald Necklace:

- Charlesgate
- Back Bay Fens
- Riverway
- Leverett Pond
- Willow Pond
- Wards Pond

amaica Pond, Arnold Arboretum and Franklin Park are not included in the Phase I Project activities See Figure 4-2).

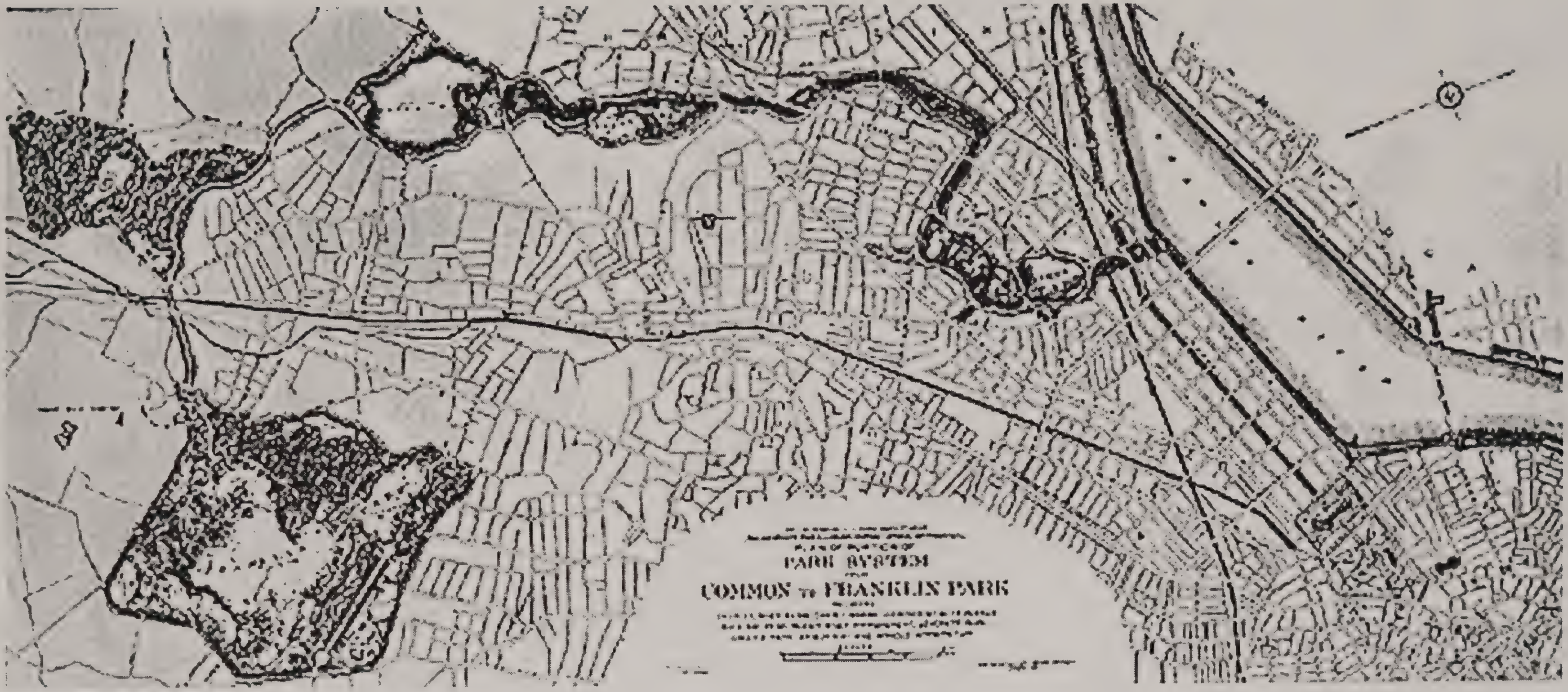
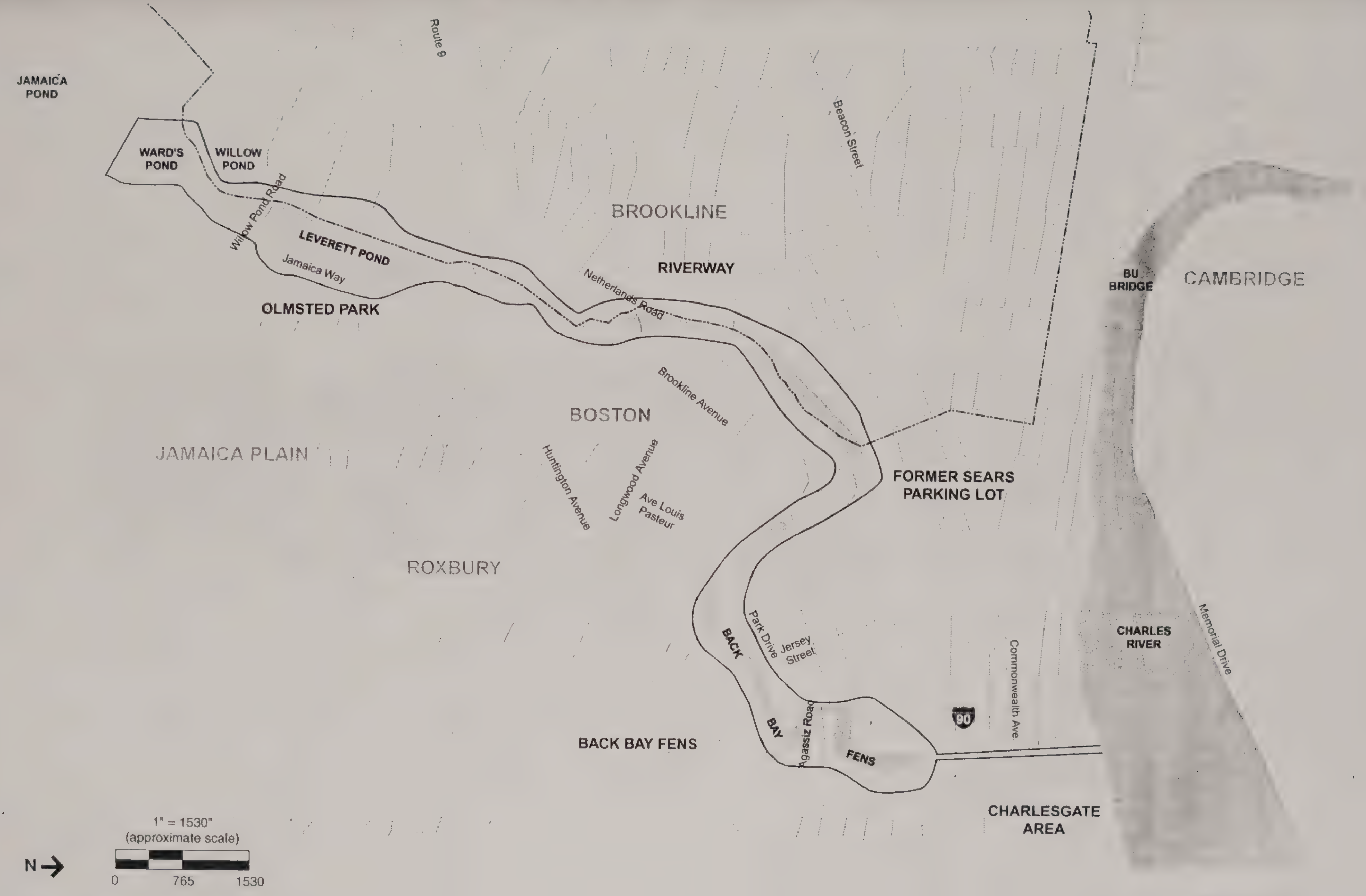


Figure 4-1
Historic Emerald Necklace Plan, 1897
Source: FLONHS



CDM Camp Dresser & McKee Inc.

Figure 4-2
Phase 1 Project Area
Source: CDM

TABLE 4-1
HISTORIC RESOURCES IN AND NEAR THE EMERALD NECKLACE (BOSTON)

Districts	Individual Structures	Institutions
Fenway District	Back Bay Fens	Berklee College of Music
Harvard Medical School District	Children's Hospital	Boston Conservatory of Music
Southwest Fenway District	Christian Science Publishing	Boston Lying-In Hospital
Symphony District	CITGO Sign	Boston Public Latin High School
Audubon Circle District	Emanuel College, Main Building	Boston University Theatre
Park Drive District	Fenway Studios	Peter Bent Brigham Hospital
St. Germain Street District	First Church of Christ Scientist	The Cotting School for Handicapped Children
St. Stephen/Symphony Road District	Forsyth Dental Center	Massachusetts College of Art
Monument Square District	Isabella Stewart Garner Museum	School of the Museum of Fine Arts
Sumner Hill Landmark District	Horticultural Hall	Thomas Morgan Rotch, Jr. Memorial Hospital for Infants
Green Street Manufacturing District	Massachusetts Historical Society	Simmons College
Glenvale Park	Museum of Fine Arts	
Hyde Square	N.E. Conservatory of Music	
	Symphony Hall	
	YMCA	
	Hastings Houses (2 and 4 Short Street)	
	Moorfield and Gertrude Storey House	
	Robert Paine, Jr. House	
	Church of Disciples	
	St. Ann's Roman Catholic Church	
	St. Cecilia Roman Catholic Church	
	St. Clements Roman Catholic Church	
	Sears Roebuck & Co. Mail Order Store	
	Fenway Park	
	New Riding Club	
	Riding School	
	Adams-Nervine Asylum	
	Arnold Arboretum	
	Olmsted Park System: Jamaica Pond	
	Park & Pinebank	
	Loring Greenough House	
	Haffenreffer Brewery	
	17 Cranston Street	
	Franklin Brewery	
	Isaac Cary House	
	Conrad Mohr House	
	Patrick W. Ford House	
	Forest Hills Boston Elevated Railroad Station	

Districts	Individual Structures	Institutions
	Our Lady of Lourdes Roman Catholic Church	
	743-745 Centre Street	
	350 Jamaicaway	
	German Methodist Church	
	Curtis Street Public School	
	Margaret Fuller School	
	Curtis/Spoohner House	
	Solomon Goldsmith House	
	Charles Q. Hill House	
	Parsonage St. John's Episcopal Church	
	44 School Street	
	106 Forest Hills Street	
	32 Sigourney Road	
	64 Sigourney Road	
	50 Atherton Street	
	276 Amory Street	
	509 Centre	
	991 Centre	
	1011 Centre	
	1085 Centre	
	1090 Centre	
	28-30 Laakeville Road	
	63 May Street	
	180 Moss Hill	
	22 Orchard	
	45 Orchard	
	96 Rockwood	
	32 Woodland	
	701-705 Centre	
	Washing Street Elevated, South of Dudley Station	

Source: Boston Landmarks Com

Table 4-2
Historic Resources in and Near the Emerald Necklace (Brookline)

Districts	*Individual Structures*	*Institutions*
Pill Hill District	20 Netherlands Road	
Longwood Historical District		

Source: Brookline Historic Preservation Commission

A basic knowledge of key aspects of the Muddy River drainage system is important to understand the routes of flow of the various sources of drainage water. The Muddy River and Stony Brook watersheds are shown on Figure 4-3. Metcalf & Eddy (1990) identified a total of 111 outfalls of small to large sizes that discharge into the Muddy River. Of these, eight of the larger drainage systems to the Muddy River are shown in Figure 4-4.

The City of Boston has one combined sewer outlet to the Muddy River- the Stony Brook Conduit. The Stony Brook watershed is considerably larger than that of the Muddy River. Stony Brook originates in Readville section of Boston and the larger part of its flow is through culverts and conduits of various sizes ending in the structure called the Stony Brook Conduit (Commissioners Channels). (See Figure 4-5) When the Stony Brook Conduit reaches the Muddy River at the Fenway behind the Museum of Fine Arts, there are two Gatehouses. Gatehouse No.1 receives water from the main Stony Brook Conduit and Gatehouse No.2 receives flow from the smaller Old Stony Brook Conduit. Water from GateHouse No. 1 (Stony Brook Conduit) flows to the Charles River via the Charlesgate East Gatehouse (MWRA Outfall 023) shown on Figure 4-5. Water from the Old Stony Brook Conduit enters the lower Charles River through the Boston Marginal Conduit and the Prison Point CSO Facility after screening and disinfecting. The old Stony Brook Conduit would only overflow under the most extreme conditions. In addition, only when there is excessively high stormwater flow (modeling by the BWSC estimates about twice a year) does the water overflow from the main Stony Brook Conduit into the Muddy River. The BWSC may also open the gates in Gatehouse No. 1 under high storm circumstances.

Since 1995, the BSWC has been conducting work on the Stony Brook Conduit. The most obvious part of the work has been vacuum apparatus that was used for recent cleaning of sediment from the conduit. The Stony Brook Conduit Project consists of the following:

- Cleaning of sediment from the main Stony Brook Conduit.
- Separation of sewers in the lower Stony Brook watershed (separate sewer systems are present in the balance of the watershed.
- Repair three sluice gates in Gatehouse No. 1 to allow more flow into the Muddy River. The fourth gate will be blocked.
- Rehabilitation to the exterior of the Gatehouse.

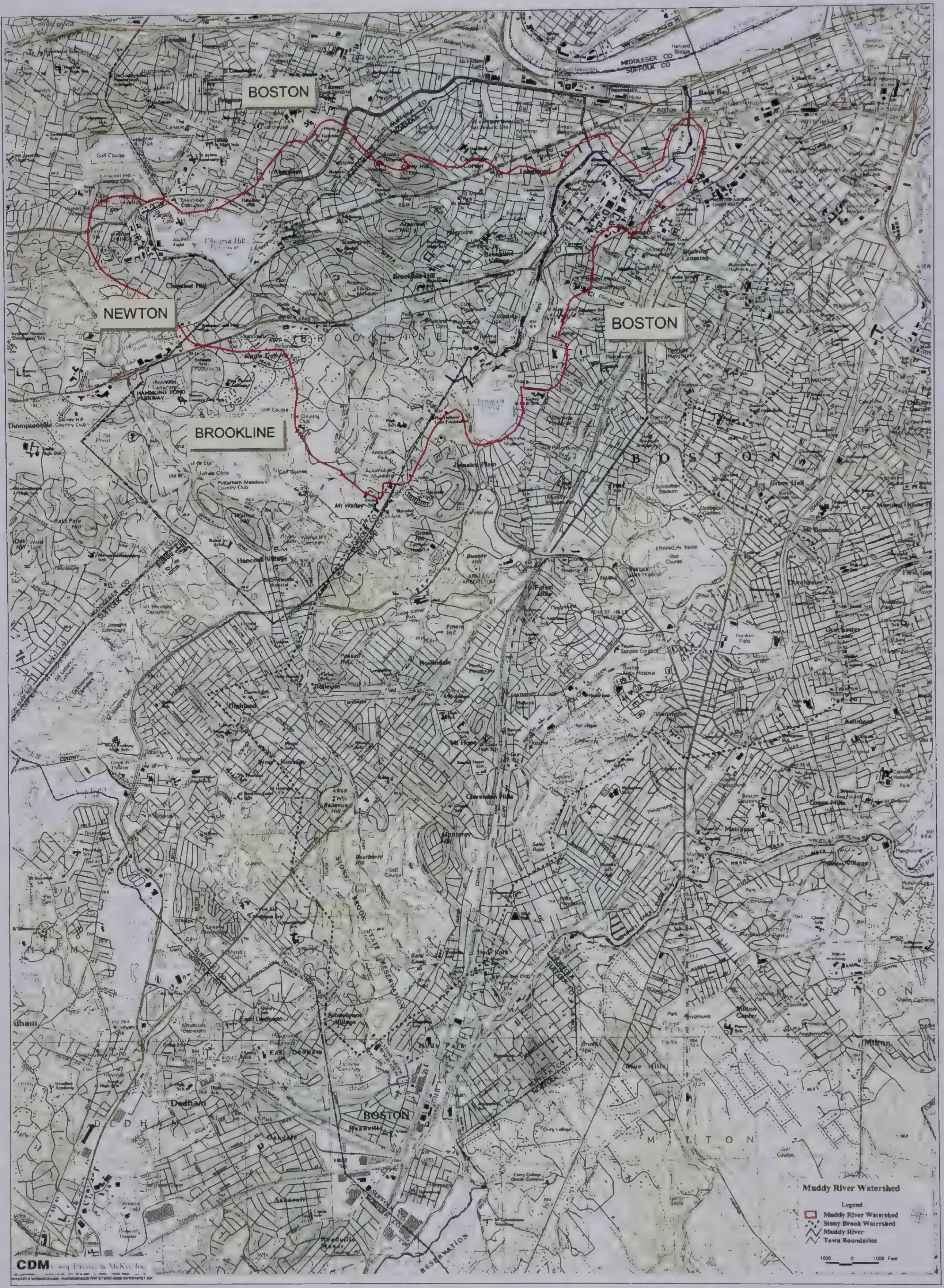


Figure 4-3
Muddy River and Stony Brook Watersheds

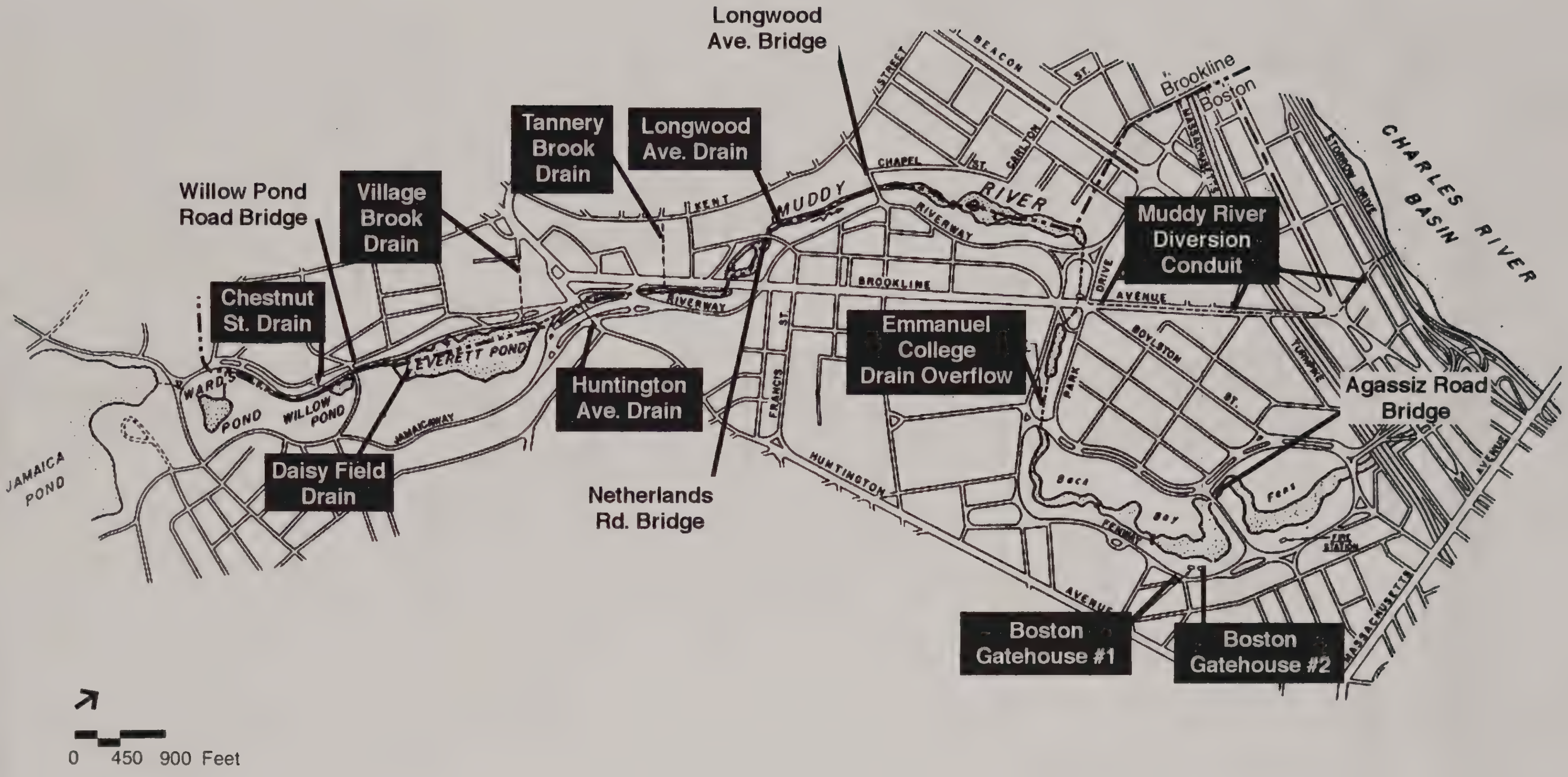


Figure 4-4
Muddy River Drainage System
Source: BPRD

Including the interior rehabilitation work, the work on the Stony Brook Conduit and Gatehouses is expected to be completed in 2002.

4.1.1 Charlesgate Area

The Charlesgate area includes the parkland that extends linearly from Ipswich Street to the Charles River (see figure 4-6) The Charlesgate area contains several main roadways including elevated Bowker interchange, Commonwealth Avenue, Beacon Street, Boylston Street and several local streets with connections to Storrow Drive. The Massachusetts Turnpike and the CSX railroad (Boston and Albany line) also bridge the Muddy River.

The land use in the Charlesgate area is both commercial and residential with a substantial number of student apartments. Kenmore Square and Fenway Park (the Boston Red Sox) are nearby, as are a number of colleges and universities (Boston University, Berkeley College of Music). The Massachusetts Bay Transportation Authority (MBTA) provides mass-transit via bus, subway and rail service.

The Charlesgate area is the furthest downstream segment of the Muddy River before it flows through large conduits under Storrow Drive and into the Charles River. The Muddy River channel in this area consists entirely of rock and concrete construction with no wetland vegetation present. Scattered stands of Japanese knotweed were observed in this area. The surrounding landscape of the river is either grass or bare ground with some trees and shrubs.

4.1.2 Back Bay Fens

As shown in Figure 4-7, the Back Bay Fens consists of a linear parkland that extends southerly (upstream) along the Muddy River from Boylston Street at the Richardson Bridge, to the Riverway/Park Drive area, in front of the new Landmark Center (formerly the Sears Building). The Back Bay Fens contains a number of intersecting roadways and is paralleled by the MDC-maintained Park Drive and the Fenway (roadway).

The Back Bay Fens contains well maintained lawn areas, numerous mature shade trees and smaller trees, and shrubs. Many paved and unpaved paths transect the park. The shoreline of the Muddy River along both sides of the Back Bay Fens is earthen, although it is heavily overgrown by extremely dense stands of giant reed grass (*Phragmites australis*) which grow along much of the bank and well out into the waterway, severely restricting its flood flow capacity. This is particularly true in the area of the Back Bay Fens GateHouse, Agassiz Road and the Victory Gardens. While some of the bank is in good condition, other parts of the bank are eroded and/or undercut.

There are abundant cultural and institutional resources in, and adjacent to the Back Bay Fens. These include: the Victory Gardens, Mothers Rest playground, the Boston Emergency Management Agency field office (a former fire station), the Duck House, War Memorial, Rose Garden, and Clemente Field. The Back Bay Fens also contains apartments and longer-term residences, the Museum of Fine Arts, the Museum School, the Gardner Museum, Northeastern University, Wentworth Institute, Berkley College of Music, MIT, Boston Conservancy of Music, Forsyth Dental School, Harvard Medical School, Emerson College, Emmanuel College, and Wheelock College.

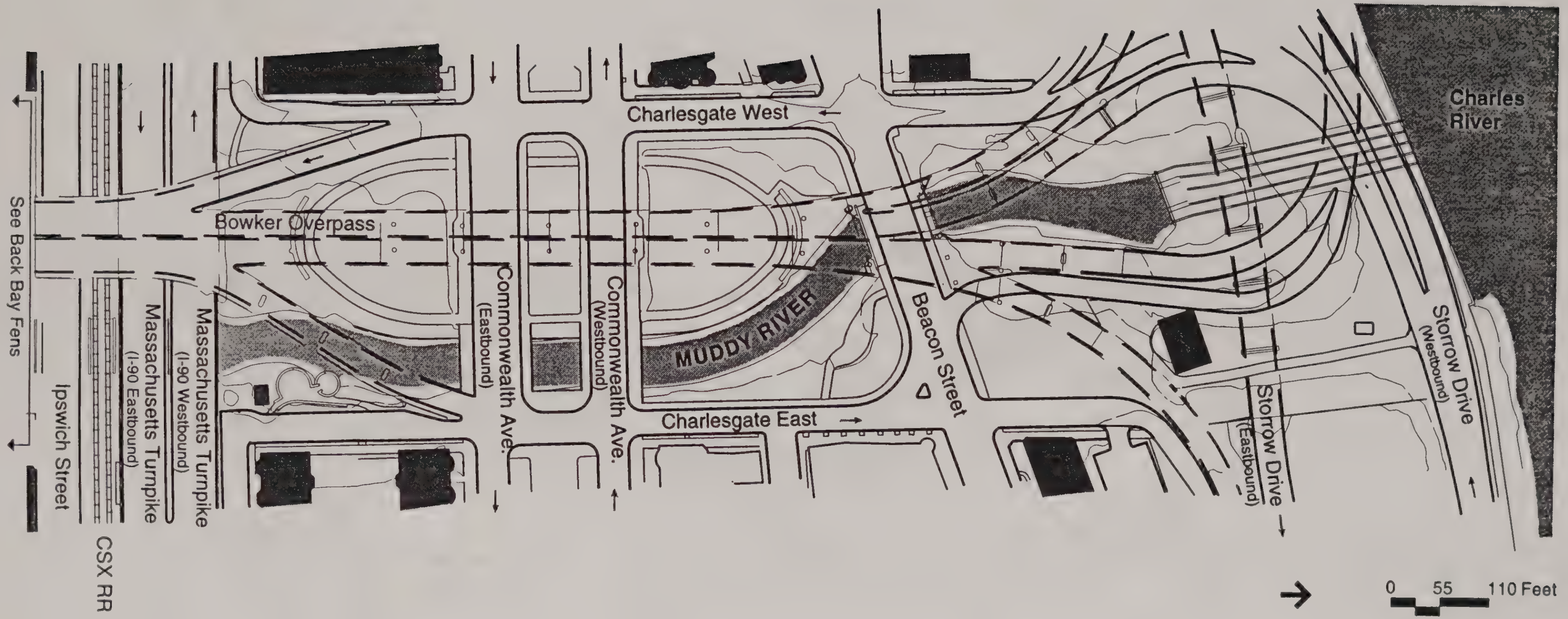


Figure 4-6
Charlesgate Area
Source: VHB, Inc.

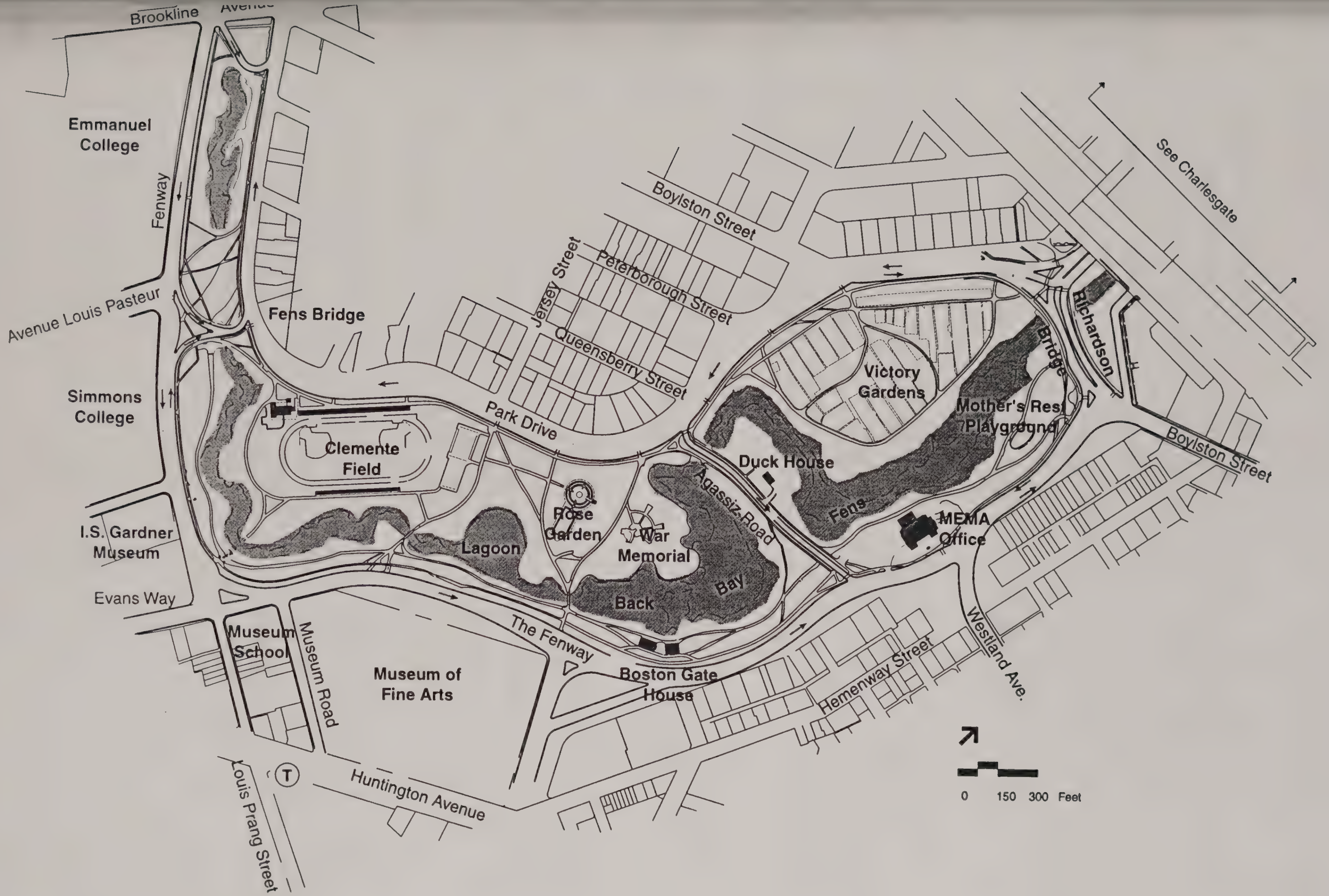


Figure 4-7
Back Bay Fens
Source: VHB, Inc.

The Back Bay Fens also contains two sections of river where the original channel has been culverted and filled over. These areas are located under the former Sears Parking Lot adjacent to the recently opened Landmark Center and abutting roadways, and upstream of the Fens Bridge at Avenue de Louis Pasteur (see Figure 4-7). As the Muddy River flows through the two 6-foot diameter culverts under the former Sears Parking Lot, it passes through a diversion chamber for the Muddy River Conduit. This conduit, which is located under part of Brookline Avenue, takes higher stormwater flows directly to the Charles River. There is a low flow weir in the Muddy River Conduit, which allows low flow water to continue into the Back Bay Fens. The Back Bay Fens contains a number of small, individual stormwater outfalls from Park Drive and the Fenway. Larger noteworthy outfalls include the overflow from the Stony Brook Conduit at Boston Gatehouse No. 1 and the Emmanuel College Drain overflow.

4.1.3 The Riverway

The historic boundary of the Riverway section of the Emerald Necklace was located at Brookline Avenue, before the segment between the Back Bay Yard and Brookline Avenue was filled for construction of the Sears Parking Lot. The Riverway currently begins at the twin 6-foot culverts at Park Drive and the Riverway roadway itself. There are also numerous cultural and institutional resources along the Riverway. These include the members of the Medical Academic and Scientific Community Organization, Inc. (MASCO), Wheelock College, the Windsor School, Simmons College, and numerous apartment and condominium units.

The Muddy River flows north from Leverett Pond into the Riverway (see Figure 4-8). The Riverway comprises a linear park along both sides of the Muddy River and consists of a maintained grassy parkland with paved and unpaved paths, and a mixture of mature Olmsted-planted trees, and, younger volunteer trees and some shrubs.

The MDC-maintained Riverway roadway runs parallel along the River's east side (Boston) with the MBTA Green Line tracks running along the west side (Brookline) until Netherlands Road where local Brookline streets are encountered. The Riverway (watercourse) is bordered on both sides with linear grassed parkland, and numerous, paralleling and intersecting roadways. With the exception of a rip-rapped channel immediately downstream of the Route 9 bridge and the area under Longwood Avenue Bridge, the shoreline of the Muddy River along both sides of the Riverway consists of naturalized terrain designed by Olmsted. Considerable lengths of the bank have no vegetative and need stabilization as they are either eroding and/or being undercut by stormwater runoff and river flow.

The Riverway contains three islands along its length, all designed by Olmsted. The only accessible island is located between Brookline Avenue and Netherlands Road, where formal stairs and bridges provide pedestrian access at the maintained island park. The other two islands are not maintained nor are they accessible. Dense growth of *Phragmites* is present along The Riverway and it has blocked the flow channel at the Island Area and has severely narrowed the flow channel at several other locations, particularly immediately upstream of the two six-foot culverts at the Back Bay Yard.

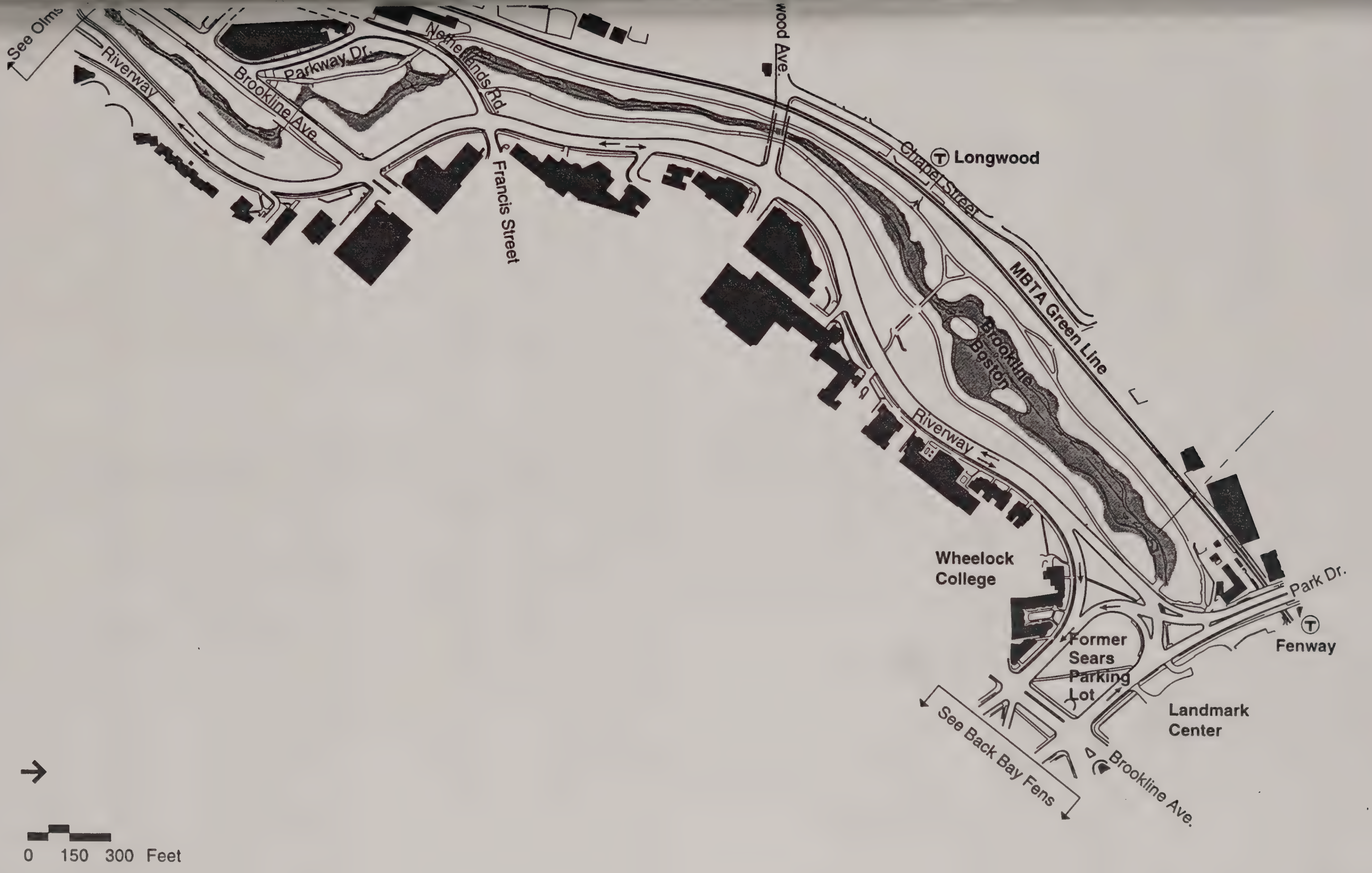
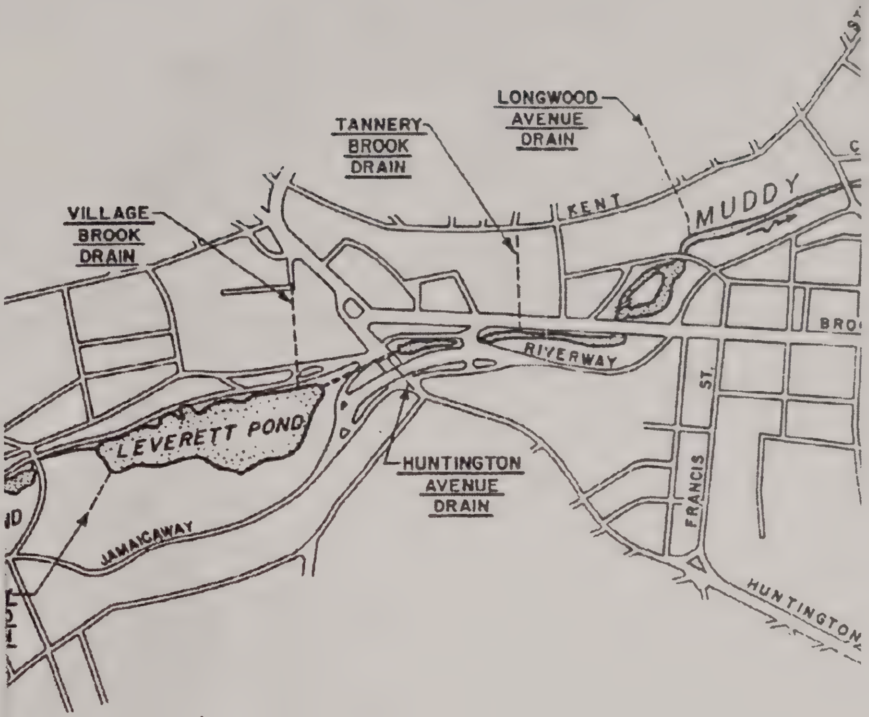


Figure 4-8
The Riverway
Source: VHB, Inc.

The Riverway contains a number of stormwater outfalls. Those that are most noteworthy include the Huntington Avenue Drain, which discharges on the Boston side of the Muddy River; and the Tannery Brook, and the Longwood Avenue Drains, both of which are located in Brookline.



4.1.4 Leverett Pond

Leverett Pond is located in the Olmsted Park portion of the Emerald Necklace (see Figure 4-9). Leverett Pond is bordered with grassed parkland along most of its perimeter. There is a earthen bank on the Boston side (east) and a gabion formed shoreline for the majority of the Brookline side (west). Roadways are evident around Leverett Pond and include Route 9 (north side), the Jamaicaway (east side), Pond Road (south side) and Pond Avenue (west side). Leverett Pond contains three islands along its western edge. The land that is immediately adjacent to Leverett Pond consists of vegetated woodlands and grassy parklands with paved and unpaved paths. Beyond the woodlands and to the east is the Jamaicaway and to the west is Pond Avenue, which separates the residential areas from Leverett Pond. The Pond is shallow (3 feet ±) and contains a large sand bar from the largest stormwater outfall into the Muddy River, the Village Brook Drain (2,060 acres).

The land use around Leverett pond includes the U.S. Veterans Administration Hospital, the New England Home for Little Wanderers, the Museum of Native Americans, and numerous apartment and condominium units.

4.1.5 Willow Pond

Willow Pond is also situated in the Olmsted Park portion of the Emerald Necklace. Steep slopes surround the pond on its eastern, southern and western sides (see Figure 4-9). Olmsted modified the then existing pond by constructing a outlet controls at the northern end and removing sediments. The land that is immediately adjacent to Willow Pond consists of vegetated woodlands and grassy parklands with both paved and unpaved paths. Beyond the woodlands to the east is the Jamaicaway; to the west is Pond Avenue, which separates the residential areas from Willow Pond. The land use beyond the bordering roadways around Willow Pond is residential.

The Chestnut Street Drain (179 acres) discharges to Willow Pond adjacent to the inlet from Wards Pond. The Chestnut Street drain has been, and continues to be, a large contributor of sediment to

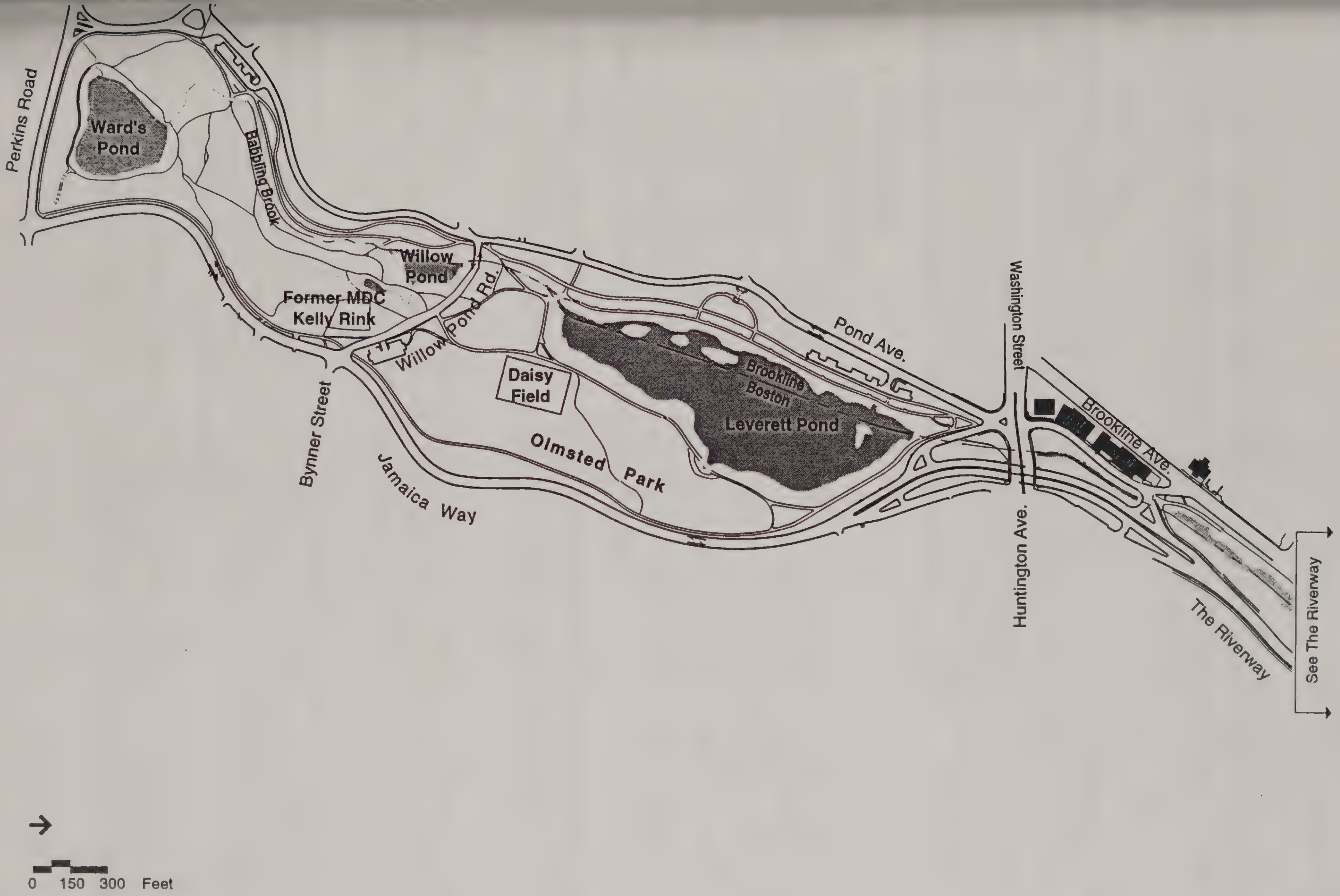


Figure 4-9
Olmsted Park
Source: VHB, Inc.

Willow Pond. The three-spine stickleback *(Gasterosteus oculeatus)* inhabits Spring Pond, which is a tributary pond to Willow Pond located to the southeast. The Massachusetts Natural Heritage Program classifies the three-spine stickleback as a rare species. The three-spine stickleback was also found to inhabit a small inlet area in Willow Pond where the water is cool and clean.

4.1.6 Wards Pond

Steep slopes surround Wards Pond on its eastern, southern, and western sides (see Figure 4-9). While Wards Pond appears to be a kettle hole pond, it shoreline was modified by Olmsted. The land immediately adjacent to Wards Pond entails vegetated woodlands with unpaved paths. A wooden boardwalk has been constructed by the BPRDalong the southern edge of the Pond to protect the wetlands and to facilitate access and use of the parkland. Beyond the woodlands to the south is Perkins Street, to the east is the Jamaicaway, and to the west is Pond Avenue, which separates the residential areas from Wards Pond. The surrounding land use is residential.

4.2 Charlesgate

4.2.1 Physical Environmental Features

The Muddy River flows from the Back Bay Fens into that portion of the Emerald Necklace that is referred to as the Charlesgate Area (see Figure 4-6). The Charlesgate Area is located entirely in Boston. It is the last portion of the Muddy River before it discharges to the Charles River. The entirety of the Muddy River in the Charlesgate Area is within a man-made stone and concrete channel. It contains bridges for a number of roadways and the bridges for the Bowker Interchange, Beacon Street, Commonwealth Avenue, MA Turnpike CSX railroad bed and Ipswich Street. The waterway is bordered on both sides by linear grassed parkland managed by the MDC. The most visible part of the Charlesgate Area is the Bowker overpass from Storrow Drive.

The Muddy River channel through the Charlesgate area does not contain wetland vegetation. For the most part, the Muddy River flows alongside the Bowker overpass. The adjacent parkland contains grass and some un-vegetated areas. Trees exist only where the Bowker overpass doesn't.

4.2.1.1 Hydrology

The hydraulic analysis is based on modeling studies performed on the Muddy River and Stony Brook Conduit systems originally prepared for the Executive Office of Environmental Affairs (EOEA) and for he U.S. Army Corps of Engineers. A more complete description of the modeling effort is found in Appendix E.

The Charlesgate area is the most downstream reach of the Muddy River. It extends from the outlet of he Muddy River at river mile (RM) 0.00 at the Charles River, up to Ipswich Street, near RM 0.27. (See Figure 1-4 of project area) While there are no major drains that contribute significant flow into this area of the river during storm events, this area conveys the largest volume of water collected by all the upstream portions of the Muddy River drainage area.

The channel in this reach generally is about 40-50 feet wide, although it narrows where it passes hrough seven bridges before discharging to the Charles River. The side slopes range from about 1:1 to about 1:3. The bed elevation ranges from about 3 feet Boston City Base (BCB) in the area of Ipswich

Street to Commonwealth Avenue, and then begins to decline to about 0.0 feet BCB before entering the last culvert under Storrow Drive. The invert of the outlet to the Charles River is about -2.4 ft BCB.

The normal water surface elevation during dry-weather is approximately 8.0 ft BCB datum, which is approximates the normal water surface elevation of the Charles River. Although the normal elevation in the Charles can vary by a few tenths of a foot, 8.5 ft was judged to be the most representative of the likely tailwater for the storms simulated by the modeling efforts due to MDC operations of the Charles River Dam. A sensitivity analysis that compared model results for the October 1996 storm shows a negligible difference in Muddy River flood levels for Charles River tailwater elevations.

The average flow during dry-weather generally is between 2 to 5 cubic feet per second (cfs) based on generalized area runoff estimates for Boston watersheds. Figure 4-10 shows a profile of the Charlesgate area with elevations for the existing bottom channel, normal water surface elevation dry-weather, and water surface elevation during the October 1996 storm. The elevations shown for the October 1996 storm, all using the 8.5-ft tailwater make are taken from the modeling analysis of the river.

The October 1996 storm, recorded at a gauge near the watershed, comprised about 10.72 inches of rain over a 37-hour period (October 19-20, 1996). This moderate to heavy rainfall over such an extended time resulted in the second largest total rainfall in the past 50 years of record.

The analysis indicates that during the October 1996 storm, the peak flow in the Muddy River in the Charlesgate area reached about 1030 cfs, with a total volume of about 515 million gallons (MG) delivered. The approximate water elevation reached during the storm at the Ipswich Street Bridge at the upstream end of the Charlesgate area was about 11.6 ft BCB. The profile is shown in Figure 4-10.

The hydraulic grade line (HGL), or water level, rose about 3 feet over the 0.27 miles of river between the Charles River and the Ipswich Street bridge during the October 1996 storm. The water surface during the October 1996 storm did not overtop bridges in the Charlesgate area although it did overtop the banks. Some of the head loss, or rise in water elevation, can be attributed to debris and sediment that accumulated over the years under the seven bridges in this reach. In addition, the analysis of the existing conditions includes a stop log structure that restricts flow severely as it passes through Ipswich Street. The stop log structure was discovered by divers during an investigation of sediment depths performed for the Boston Water and Sewer Commission.

Despite this rise in water elevation, the Charlesgate area did not suffer from significant flooding. Instead, the rise in elevation observed in this reach had an impact in the upstream locations of the Muddy River, as described later in the Back Bay Fens and Riverway sections.

4.2.1.2 Sediment Quality

The borings advanced in the Charlesgate area (Summer 2000) generally were completed to a depth of ten feet below the top of sediment or native material was encountered. The material encountered consisted of varying thickness (4 to 8 ft) of a soft, black, organic silt layer, intermixed with fine to coarse sand and gravel. The native material underlying the organic silt layer typically was observed at four to eight feet below the top of the sediment. Native material consists of grey, loose to medium dense, fine to medium sand with varying amounts of fine gravel and silt. Petroleum odors were noted at several depth intervals at boring location CG-SED-4.

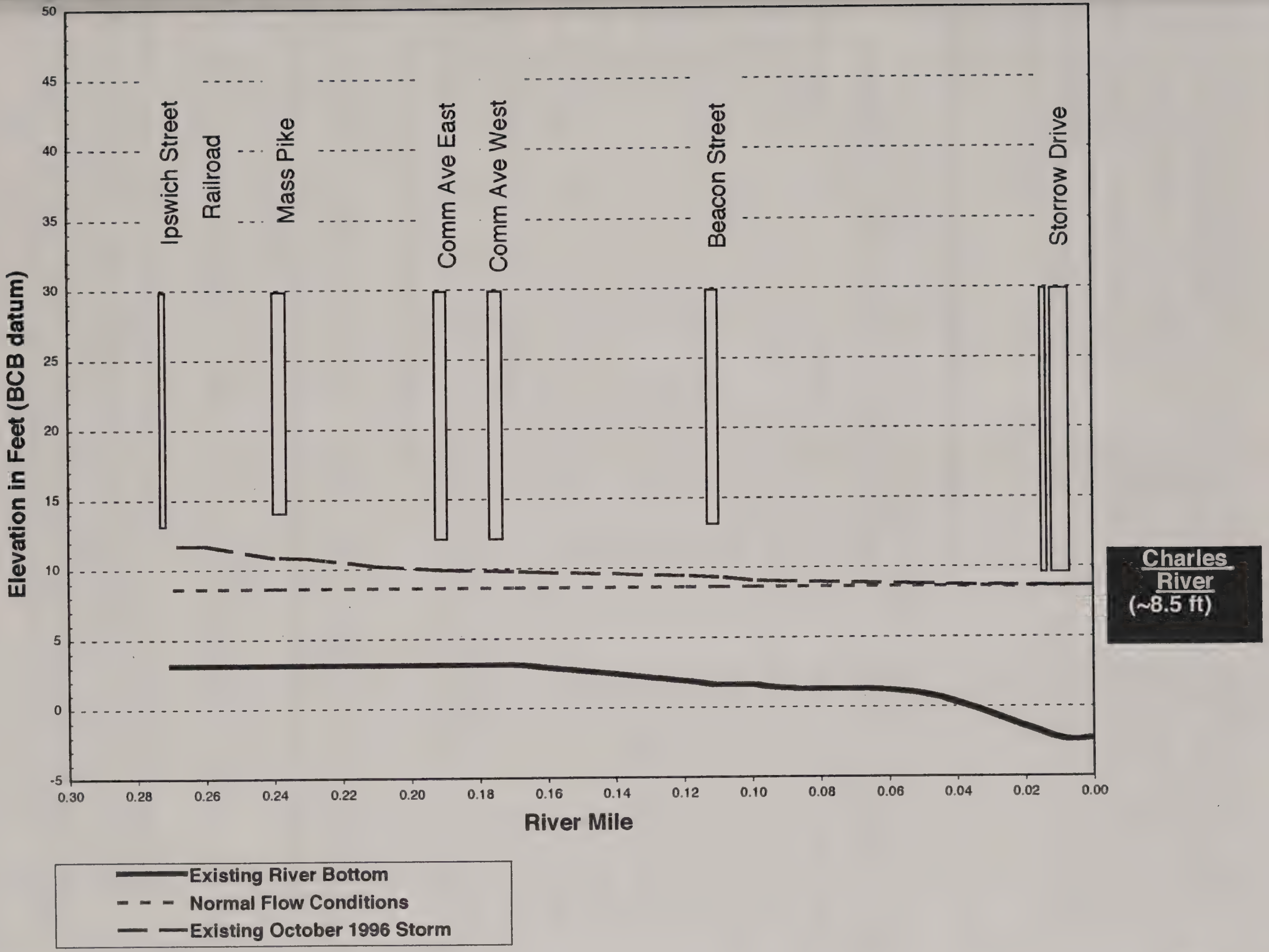


Figure 4-10
Peak Hydraulic Grade Line–October 1996 Storm
Existing Conditions–Charlesgate Area

Collectively, the analytical results of the sampling conducted in the Charlesgate area were lower in concentration than the other areas. The results are summarized in Table 4-3. The concentration of PAHs ranged from below detectable levels to 29 mg/kg. Elevated concentrations of VPH were found in the 0 to 2 ft depth interval at CG-SED-4 (11.5 mg/kg) and CG-SED-6 (8.2 mg/kg). Petroleum odors were noted during sample collection at location CG-SED-4. However, none of the target VPH compounds (benzene, toluene, ethylbenzene, xylenes, and methyl-tertbutyl ether) were detected. The total of the PCB aroclors was well below 2 mg/kg, and ranged in concentration from below detectable levels to 0.325 mg/kg.

Table 4-3
Summary of Sediment Analytical Results - Charlesgate Area

Contaminant	No. of Samples	Concentration[1]		DEP Landfill Reuse Levels[1]		No. of Samples Exceeding	
		Minimum	Maximum	Unlined	Lined	Unlined	Lined
Total Arsenic	17	Not Detected		40	40	No Exceedances	
Total Cadmium	17	ND	0.93	30	80	No Exceedances	
Total Chromium	17	5.7	68	1000	1000	No Exceedances	
Total Lead	17	ND	250	1000	2000	No Exceedances	
TCLP Lead (mg/L)	3	Not Detected		NA	NA	No Exceedances	
Total Mercury	17	ND	0.48	10	10	No Exceedances	
Total EPH	17	ND	130	2500	5000	No Exceedances	
Total PCBs	13	ND	0.33	<2	<2	No Exceedances	
Total PAHs	17	ND	29	100	100	No Exceedances	
Total VPH	17	ND	11.5	NA	NA	No Exceedances	
Total VPH Target	17	ND	1	4	10	No Exceedances	
Reactive Sulfide	13	ND	450	500		No Exceedances	
Reactive Cyanide	13	Not Detected		250		No Exceedances	
pH	13	6.4	9	2 < pH < 12.5		No Exceedances	
Conductivity	13	80	1500	4000 umhos/cm	8000 umhos/cm	No Exceedances	

[1] All results are reported in mg/kg unless otherwise noted.

Lead concentrations ranged from below detectable levels to 250 mg/kg. The results from TCLP tests run on three samples all were below the regulatory limit of 5 mg/L. Samples were collected from the Charlesgate area and composted into a sample to be tested for the paint filter test. The result showed that free liquids were present.

The methodology for the sediment test program, analytical results, and summary figures are included in Appendix F.

Elutriate analyses were conducted on sediment from the Charlesgate area in order to determine, if during the process of hydraulic dredging, if any toxic metals could be released to the environment. The metals that were analyzed included those that are required by the ACOE and the MA DEP, i.e. antimony, arsenic, beryllium, cadmium chromium, copper, lead, mercury, nickel, selenium, silver, thallium, zinc. In the elutriate analysis procedure, sediment is mixed with water at the same general ratio as would occur during hydraulic dredging, i.e. 1 part of sediment to 5 parts of water. The sediment and water are mixed, filtered, and tested. The receiving water is also tested for the same constituents. The difference in concentrations indicate the magnitude of the toxins that could be released during the dredging. The sample location(s) that were selected were done so because the results of the bulk sediment characterization indicated high levels of contamination. An elutriate analysis was conducted on sediment that was collected from the Charlesgate area just upstream of the Ipswich Street bridge at the location of sediment sample CG Sed 2 as shown on Figure F2-1A in Appendix F. The test did not result in any release of contaminants.

4.2.1.3 Water Quality

The Charlesgate portion of the Muddy River contains a number of stormwater outfalls from Beacon Street, Commonwealth Avenue, the Massachusetts Turnpike (I-90), Ipswich Street, the Bowker overpass and ramps, and other local drains. The Massachusetts Department of Environmental Protection (MA DEP) has established Water Quality Standards for all waters in the Commonwealth. The Muddy River watershed has been classified as Class B waters. As such, Class B waters are considered swimmable and fishable.

In order to assess the water quality of the Charlesgate Area, a review of the water quality history was conducted. Historical water quality data includes that from the:

Division of Water Pollution Control (now the MA DEP)	1974
Division of Water Pollution Control (now the MA DEP)	1986
Army Corps of Engineers (ACOE)	1992

The historical data indicated that bacteriological, Water Quality Standard (Fecal coliform bacteria <200 bacteria per 100 ml of water) and/or the dissolved oxygen water quality standards (>5 mg/1 or 75 % of saturation) were not met in 1974, 1986, and 1992. Temperature (<20°C) and pH (6.5-8.3 units) standards were met during these years.While the Water Quality Standards do not have numeric criteria for suspended solids, nitrogen and phosphorus, certain limnological (the study of freshwater ecology) water quality values were applied to the Muddy River because of its lentic (very slow moving) character. These criteria were 20 milligrams per liter (mg/l) for total suspended solids (TSS), 0.30 mg/l for inorganic nitrogen (the summation of nitrate, nitrite, and ammonia nitrogen forms), and 0.01 mg/l fo total phosphorus. Applying these values against the historical data, it was noted that there have been excessive nutrient conditions in the Charlesgate area during the years 1974, 1986, and 1992 .

Many of the cross connections between sanitary sewers and combined sewers in the upstream portion of the Muddy River drainage system have been corrected and sewer separation work is continuing. There are numerous municipal projects that either have been complete or are in progress to correct the sanitary sewers and storm sewers. These include ongoing work by the Boston (including BWSC) and Brookline for; sewer separation, the continuation of the Stony Brook Conduit Project, the implementation of the Boston Catch Basin Improvement Project, continuing the elimination of illegal cross connections, stormwater management and monitoring programs, permitting of large sewer user and regulation of industrial discharges, permitting of new or retrofitted building project through the BWSC's Site plan Review procedure, other NPDES-related compliance efforts. These programs have resulted in substantial water quality improvements by reducing the very high bacteriological contamination that past data show existed. The street sweeping and catch basin cleaning programs in oth have been increased. Both municipalities operate used motor oil collection centers and collect azardous wastes twice per year.

uring the autumn of 2000, the water quality of the Muddy River and associated large discharge utfalls (see Figure 4-11) were analyzed for key water quality constituents. While sampling and testing ere not conducted in the Charlesgate area, the water quality results for the Muddy River at the gassiz Road Bridge would be reasonably descriptive of the water quality in the Charlesgate area. ecause they are only separated by 2000 ft and the area is without any intervening large storm drains nd or other discharges

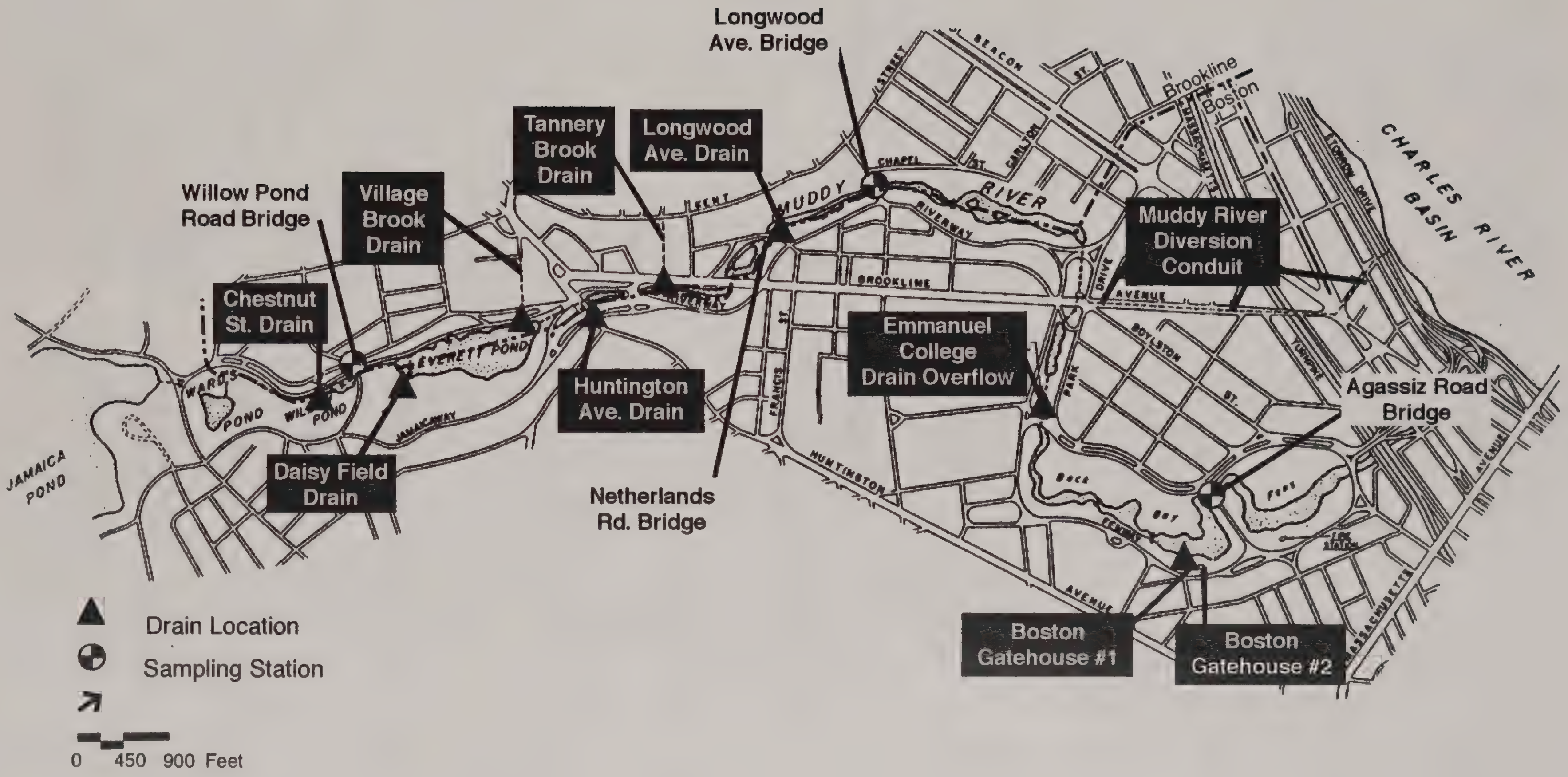
t the Agassiz Road bridge, the Muddy River was found to contain dissolved oxygen concentrations as ell as oxygen saturation values that were at or above the water quality standards of 5.0 mg/l and 75% saturation during dry and wet weather conditions. The pH of the Muddy River in this area was und to be more alkaline during dry weather, possibly due to algae growth. The pH decreased during et weather conditions, possibly attributable to the low pH of the rainfall and associated stormwater noff. The water was moderately well buffered against rapid changes during the dry and wet weather mpling events. Turbidity and total suspended solids were considerably lower during the dry eather than the wet weather conditions. The color values suggested there were some dissolved umic materials in the water. The nutrient content of the water was higher during wet weather than uring dry conditions with total phosphorus levels being five times higher under wet weather nditions. Fecal coliform bacteria levels exceeded the water quality standard of 200 colonies per 100 l of water during both dry and wet weather conditions, with the higher concentration being found nder wet conditions. In keeping with EPA guidance, the Massachusetts Department of nvironmental Protection is developing guidelines for nutrient limitations where the technology based oint and non-point source pollution controls are not stringent enough to meet the water quality andards. These guidelines are planned to be issued in 2003.

.2.2 Biological Environment

he Charlesgate area is a maintained urban park with extensive lawns, some mature trees, and few rubs. *Phragmites* does not grow in this area. Scattered stands of Japanese knotweed are present. The llowing sections include information on the existing woodlands, horticultural resources, aquatic and ildlife resources, and wetlands along the Charlesgate section of the Muddy River.

2.2.1 Upland Vegetation and Horticultural Resources

e inventory, documentation, and analysis of vegetation in the Charlesgate area were completed in ugust of 2000. The area includes the watercourse from the Charles River to the Boylston Street Bridge ichardson Bridge). The scope of work included documentation of trees, shrubs, vines, and lawn areas cluding notation of areas of bare lawn and erosion.



CDM Camp Dresser & McKee Inc.

Figure 4-11
Muddy River Sampling Stations
Source: BPRD

Vegetation breakdown under trees includes:
Deciduous trees - indicating species, caliper and condition
Evergreen trees - indicating species, caliper and condition
Woodland

Vegetation breakdown under shrubs includes:
Restored planting with five years of restoration
Shrub massings
Invasive plant colony - indicating species

Erosion includes:
Bare lawn
Erosion area
Wash outs of storm sewers
Desire lines
Overuse compaction
Surface roots of trees

Analysis of Existing Vegetation is contained in Table 4-4.

Table 4-4
Inventory and Analysis of Existing Vegetation - Charlesgate

Category	Unit	Total	Good	Fair	Poor	Dead
Trees:						
Canopy tree	each	233	69	152	12	7
Flowering tree	each	27	8	18	1	0
Evergreen tree	each	45	26	19	0	0
Heritage tree[1]	each	12	9	2	1	0
Total Trees:		**317**	**112**	**191**	**14**	**7**
Shrubs:	(Estimated)					
Restored planting	square footage	0				
Shrub massing	square footage	1,890				
Total Shrubs:		**1,890**				
Invasive Plant Colonies:	(Estimated)					
Phragmites	square footage	13,539				
Other Invasives (e.g.Knotweed)	square footage	9,415				
Total Invasive Plant Colonies:		**22,954**				
Woodland:	(Estimated)					
	square footage	0				

Note: A heritage tree is a canopy tree with a 32" or greater caliper. If it is listed as a heritage ree, it will not be listed as a canopy tree.

In accordance with the Commonwealth of Massachusetts Department of Environmental Management standards, trees that are 32" inches in caliper and over are considered to be heritage trees. All trees have their species and caliper size identified and the condition of the heritage trees is rated as good, fa or poor as are all other trees on the site. The diameter of the circle for tree canopy is in relation to its caliper size.

Plan documentation is contained in the Appendices in the form of annotated Existing Conditions Plan (Appendix C)

4.2.2.2 Aquatic and Wildlife Resources

Under normal flow conditions, the Charlesgate area exists as a sluggish moving stream with a general width of 40 feet (±). Sandbars are evident at some points. Due to the watershed's highly developed and impervious nature, the volume of base flow is very low, resulting in almost stagnant conditions during prolonged dry periods. The mean annual flow is calculated to be 8 cubic feet per second (cfs) and the seven day- 10 year low flow volume is <0.05 cfs.

The quality and physical characteristics of water in the Charlesgate area were determined by the quality of the water as it flows from the Fens and upstream reaches. The water in the Charlesgate are is warm in the summer as well as turbid throughout the year as a result of algae growth and/or suspended sediments. The nutrient content of the water is most likely high. The surface sediment in the Charlesgate area (see Section 4.2.1.2 – Sediment Quality) was found to contain varying concentrations of petroleum hydrocarbons, polynuclear aromatic hydrocarbons (PAHs) and heavy metals. Polychlorinated biphenyls (PCBs) and dichlorodiphenyltrichloroethane, p,p' (DDT) were not found.

Aquatic vegetation observed in the Charlesgate area includes fanwort (*Cabomba caroliniana*), duckwee (*Lemna minor*), and filamentous algae.

Fish Resources

Species-specific information on fish resources in the Charlesgate area is not available. However, it is reasonable to assume that a similar composition of fish to those, which dwell in the Back Bay Fens als is present in the Charlesgate area. This would include the following indigenous species:

Large Mouth Bass	*Micropterus salmoides*
Pickerel	*Esox sp.*
Yellow perch	*Perca flavascens*
Bluegill	*Lepomis macrochirus*
Pumpkinseed	*Lipomis gibbosus*
American eel	*Anguilla rostrata*
Common Shiner	*Notropis cornutus*
Golden Shiner	*Notemigonus crysoleucas*
Goldfish	*Carassius sp.*
Common carp	*Cyprinus carpio*

In 1990, the Massachusetts Division of Fisheries and Wildlife conducted PCB analyses on the tissue o fish that had been collected from the Riverway and Back Bay Fens. The tests indicated that PCBs wer contained in the edible tissue of the fish above the USDA Action Level and a Public Health Advisory was issued.

Wildlife Resources
The wildlife resources of The Charlesgate area include avian and non-avian species. The Charlesgate area does not contain wetland vegetation or any natural environmental amenities. Therefore, the Project's Wildlife Habitat Evaluation and Vegetation Assessment did not extend to this area, but ended at the Back Bay Fens. Local wildlife likely to occupy the area include the following:

Birds

American Crow	*Corvus brachyrhynchos*
American Robin	*Turdus migratorius*
Black-capped Chickadee	*Parus atricapillus*
Blue Jay	*Cyanocitta cristata*
Common Grackle	*Quiscalus quiscula*
European Starling	*Sturnus vulgaris*
Gray Catbird	*Dumetella carolinensis*
Herring Gull	*Laurs argentatus*
House Sparrow	*Passer domesticus*
Pigeons	*Columba spp.*
Tufted Titmouse	*Parus bicolor*

Reptiles

Common Musk Turtle	*Sternothaerus odoratus*
Red Eared Slider	*Chrysemys scripta*

4.2.2.3 Rare Species

The Massachusetts Natural Heritage Program was consulted (see Appendix K) and Endangered, Threatened Rare species are not reported to inhabit the Charlesgate area.

4.2.2.4 Wetland Resources

The wetland resources in the Charlesgate area were examined during the spring and summer of 2000 with none being found. An Abbreviated Notice of Resource Area Delineation (ANRAD), which contained the wetland delineation plans, was presented to the Boston and Brookline Conservation Commissions and accepted by both Commissions in September 2000.

The wetland delineation at Charlesgate area resulted in the following resource area findings:

Bank	2,120 lf
Land Under Water	64,000 sf
Vegetation growing in Land Under Water	0 sf
Bordering Vegetated Wetland	0 sf

4.2.2.5 Ecological Functions and Values

An Ecological Functions and Values analysis was conducted by following the US Army Corps of Engineers Highway Methodology (Supplement, November 1995). The purpose of the Functions and Values analysis is to provide as non-biased an assessment of the habitat and wildlife as possible.

The bottom and side walls of the Charlesgate area are concrete/rocklined, therefore no hydric soils are associated with this section of the watercourse. No wetland vegetation was found in this area. Because no bordering vegetated wetland was associated with this section, a review of the functions and values was not performed.

4.2.3 Cultural Environment

4.2.3.1 Historic Resources

Historically, the Charlesgate area has a Primary Period of Significance of 1878-1895, which is the Frederick Law Olmsted design for the area as documented by drawings from 1879 to 1896. Olmsted referred to this area as the "Beacon Street Entrance". The 1879 "Proposed Improvement of Back Bay" plan shows Beacon Street, Commonwealth Avenue and the Boston and Albany Railroad Bridge crossing over the Muddy River. The railroad passes under a road (Charlesgate West) that connects Commonwealth Avenue to Boylston Street and Audubon Road (Park Drive) in an area that is referred to as Gaston Square. The Olmsted period drawings continue to show Commonwealth Avenue as a curving roadway with informal plantings, not as a formal, straight avenue. During this period the formal avenue with four rows of trees in the median and a single row of trees at both adjacent sidewalks starts at Charlesgate East and continues East.

The Fens, as the Back Bay was known, was a salt creek bordered by salt marshes that emptied into the tidally affected Charles River. Construction of the Charles River tidal gates began in 1881 . They were ready for operation in 1882. The Muddy River Conduit to the Charles was introduced in 1883. The "Back Bay Revised Plan of the Northerly Part including Beacon Entrance" illustrates the 1892 condition (see Figure 4-12).

Planting design in this area is documented on the 1884 Planting Plan for the Beacon Street Entrance (FLONHS). A planting list compiled from several sources is provided by Cynthia Zaitzevsky in Frederick Law Olmsted and the Boston Park System, page 188 (see Figure 4-13).

Even though the quantity of vegetation planted was extensive by 1885 and 1886, it was obvious that, with the exception of some upland vegetation, which survived, the majority of the plantings did not. A second planting that is undocumented, except for photographic evidence in 1896, seems to have been successful. The 1887 Lithograph of Olmsted's design, below, illustrates the conditions when the river was still tidal (see Figure 4-14).

Grading for the area and the establishment of the shoreline are documented on two grading studies by John C. Olmsted and Warren Manning in 1882 FLONHS #923-52 and FLONHS #930-81. Photographic documentation for Charlesgate is limited for the Olmsted Period. The Secondary Period of Significance for the Charlesgate Area is 1910-1931. The Arthur A. Shurtleff design for the area is documented by a series of studies by Shurtleff from 1912 to 1931 that modify the Olmsted design for Commonwealth

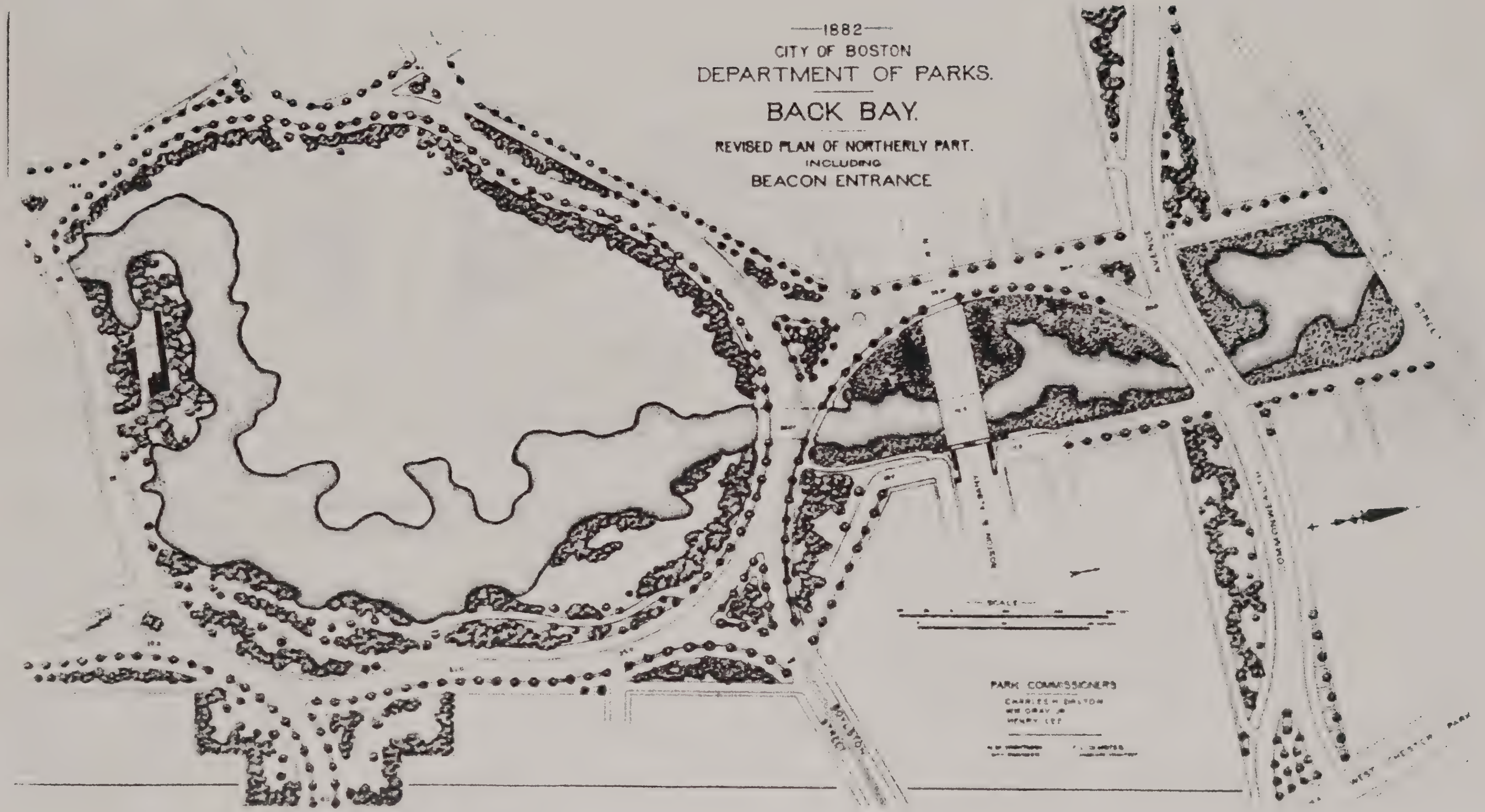


Figure 4-12

Back Bay Revised Plan of the Northerly Part including Beacon Entrance, 1884

Source: FLONHS

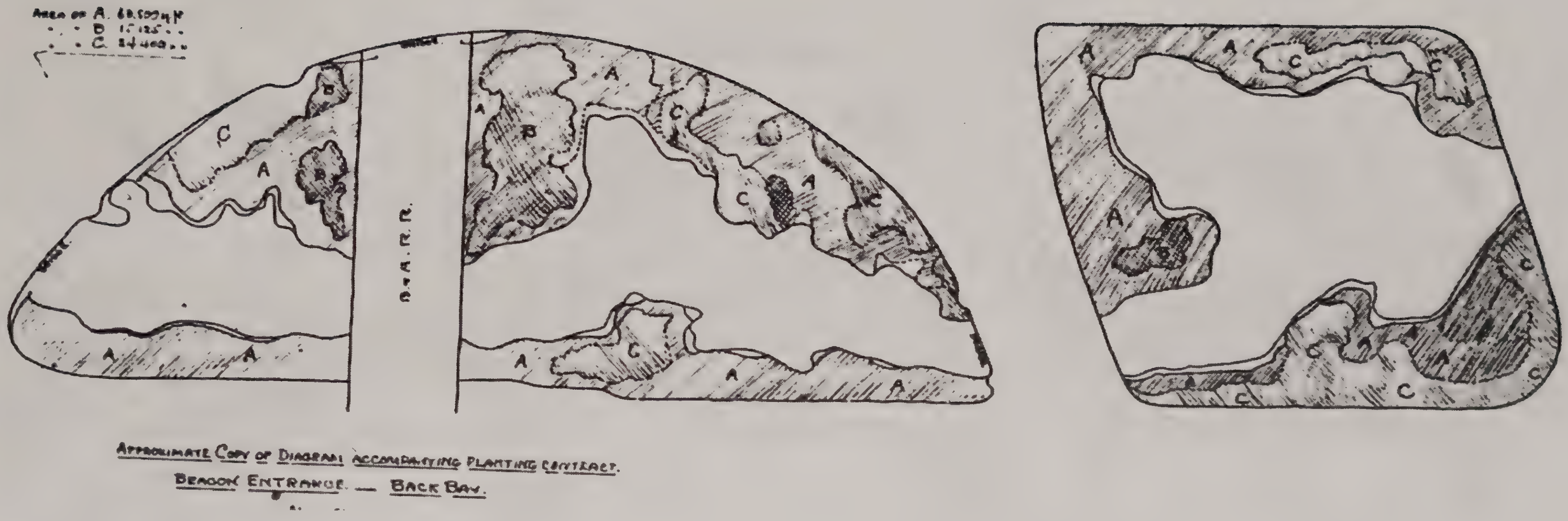

Area of A. 68,509 sq ft
" " B 15,125 " "
" " C 24,400 " "
A
B
C
B.&A.R.R.
Approximate Copy of Diagram accompanying Planting Contract.
Beacon Entrance — Back Bay.

Figure 4-13
Planting Plan for the Beacon Street Entrance, 1884
Source: FLONHS

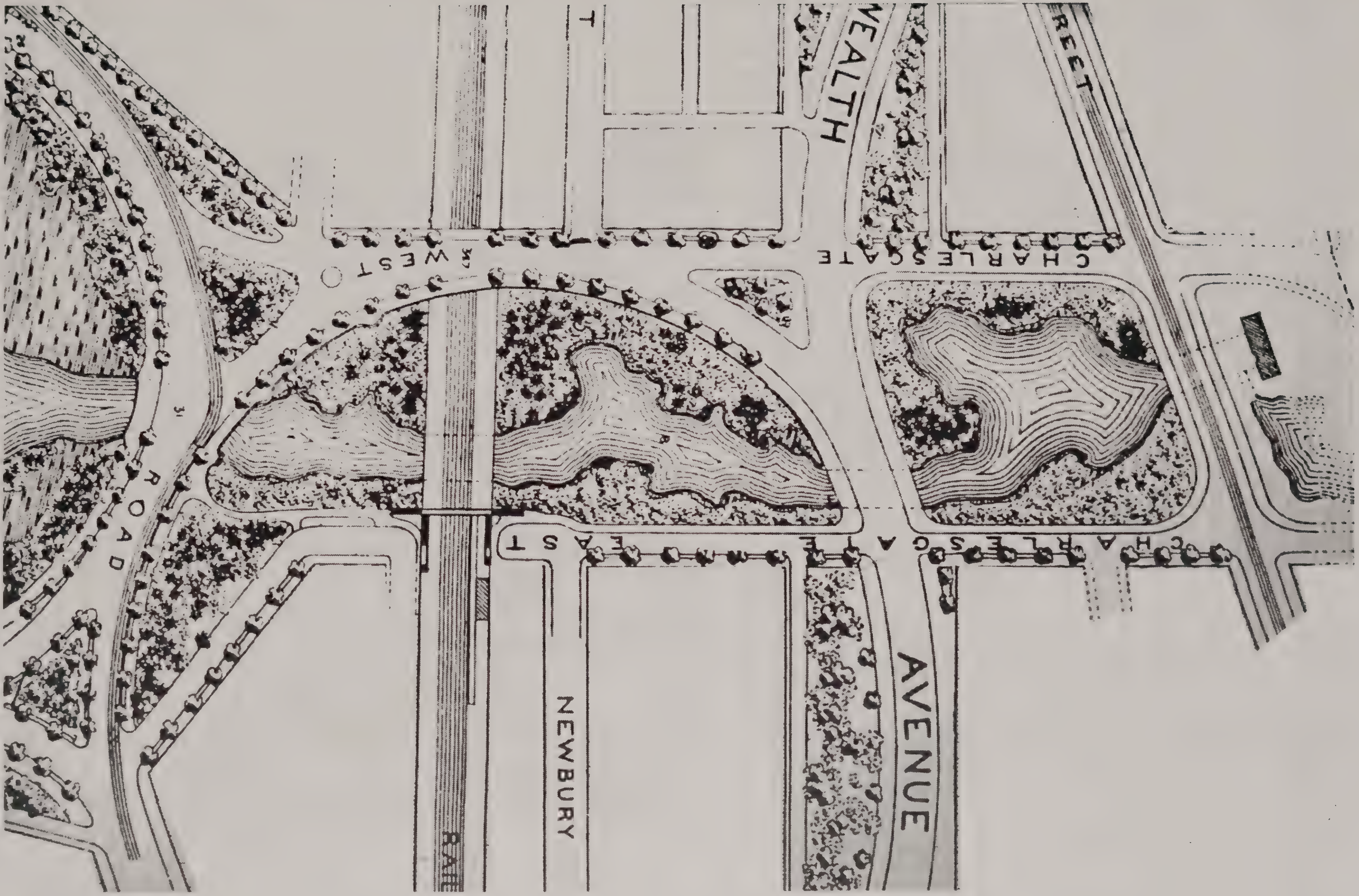


Figure 4-14
Map of the Back Bay Fens, Commonwealth Ave., Beacon St., and Audubon Rd, Dec. 3, 1887
Source: FLONHS

Avenue and part of the waterway. The proposals straightened the avenue from Charlesgate East to the Beacon Street intersection to the west and continued the rows of trees east of Charlesgate East (see Figure 4-15).

The documentation includes studies of the median width and MTA (MBTA) redesign of minor adjacent roads, and the construction of new bridging with balustrades in the formal classical style, completed by 1925. There also was a series of designs for a "Boat Haven" at the Charles River below the gates and studies of a proposed overpass connector from the Charles River Parkway (Storrow Drive) to Gaston Square at Boylston Street over the Muddy River. These elements were not completed. Drawings in 1928 and 1931 show informal and formal schemes for the never-completed connector overpass (see Figure 4-16).

In 1919, the Metropolitan Park Commission and the Massachusetts Water and Sewer Commission were merged to form the Metropolitan District Commission (MDC), combining the Metropolitan Parks and Parkways' responsibilities with the function of water supply and sewerage for the state. The MDC prepared a series of studies from 1949 to 1957 that culminated in the 1963-64 construction of the current Bowker Overpass designed to connect James J. Storrow Memorial Drive (i.e., the Charlesgate Interchange) to Audubon Road (Park Drive). The MDC began this modification process with the taking of the Fens parklands from Beacon Street to the Charles River in 1950. The major overpass, as developed, impacts both light and water in this area and creates isolated areas that cannot be viewed from the adjoining streets. The homeless have occupied these isolated areas over time.

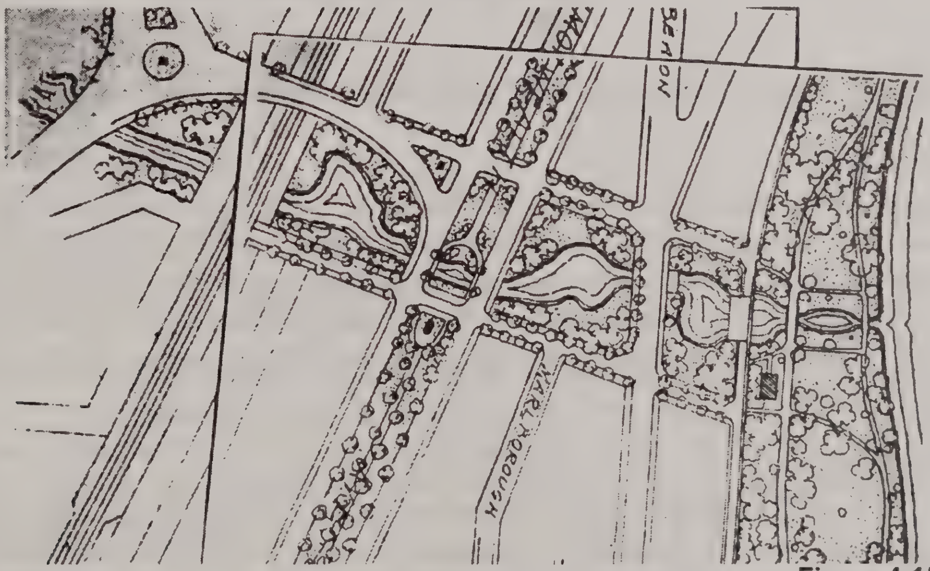


Figure 4-15
Charles River Basin Preliminary Plan,
BPRD Arthur A. Shurtleff, 1931
Source: BPRD

In 1952, Chapter 354 of the General Acts authorized the Massachusetts Turnpike Authority to take lands for the Massachusetts Turnpike (I- 90) Extension into downtown Boston. The taking was parallel with the railroad right of way at Charlesgate. The taking, completed in 1962, included the width of the Fens between the Railroad Bridge and Commonwealth Avenue. The Richardson iron Railroad Bridge, constructed in 1880 was destroyed as part of this taking. The Commonwealth Avenue and Beacon Street Bridge were restored in the 1980's. The arches and historic balustrades were restored. On April 25, 1978, Commonwealth Avenue Mall, including Charlesgate, was designated a Landmark by the Cit of Boston, under Chapter 772 of the acts of 1975. Charlesgate is contained with in the Back Bay Histor District of National Register of Historic Places.

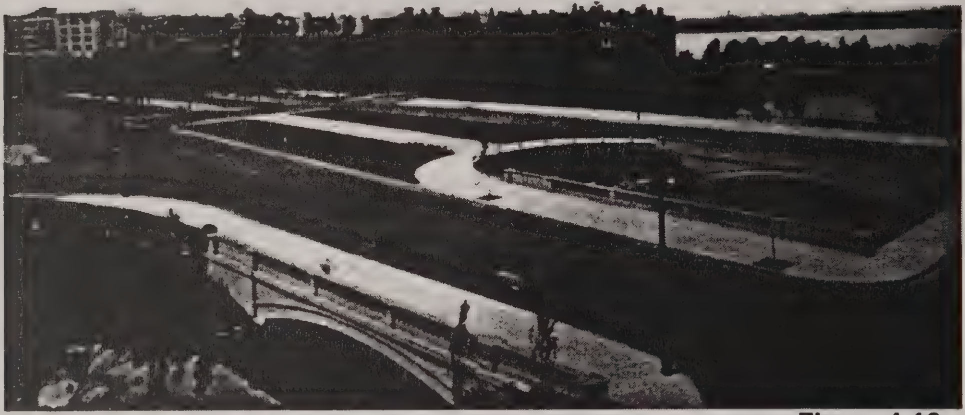


Figure 4-16
Charlesgate East and West, Arthur A. Shurtleff, 1930's
Source: BPL

The list of Historic Plans and Plant Lists for the Fens area is contained in the Appendix C.

4.2.3.2 Land Use

In the Charlesgate area, the land use from Storrow Drive to Boylston Street is primarily residential on both sides of the river. The land located immediately adjacent to the Charlesgate area consists of a maintained grass parkland with paved and unpaved paths, and a mixture of mature Olmsted-planted trees as well as younger trees and some bushes. The Charlesgate area is transected by a number of roadways including Beacon Street, Commonwealth Avenue, The Massachusetts Turnpike, the CSX railroad bridge, and Ipswich Street.

4.2.3.3 Recreation

Passive recreation in the Charlesgate area is limited to a series of poorly lit seating areas. There is no active recreation in this location. Limited use of this area today is attributed to it lacking a pedestrian path parallel to the river and to the domination and shading of the space by the MDC overpasses.

Pedestrian Access

Pedestrian conditions in the Charlesgate area were examined recently. Depicted on Figure 4-14, this area serves as a key link for pedestrian flows from the Massachusetts Avenue corridor and the Back Bay Area to Kenmore Square/Fenway Park/Boston University.

Pedestrian demand data were collected on key sidewalks along Commonwealth Avenue in July 2000 from 8:00 AM to 6:00 PM on a weekday when there was a Red Sox home game scheduled. The weath at the time of these counts was amenable to pedestrian activity (i.e. warm temperature, no rain). Weekday counts at these time intervals were chosen to be consistent with typical periods of activity for a construction project. Table 4-5 provides a summary of the demands that were observed. These are also depicted graphically on Figure 4-17.

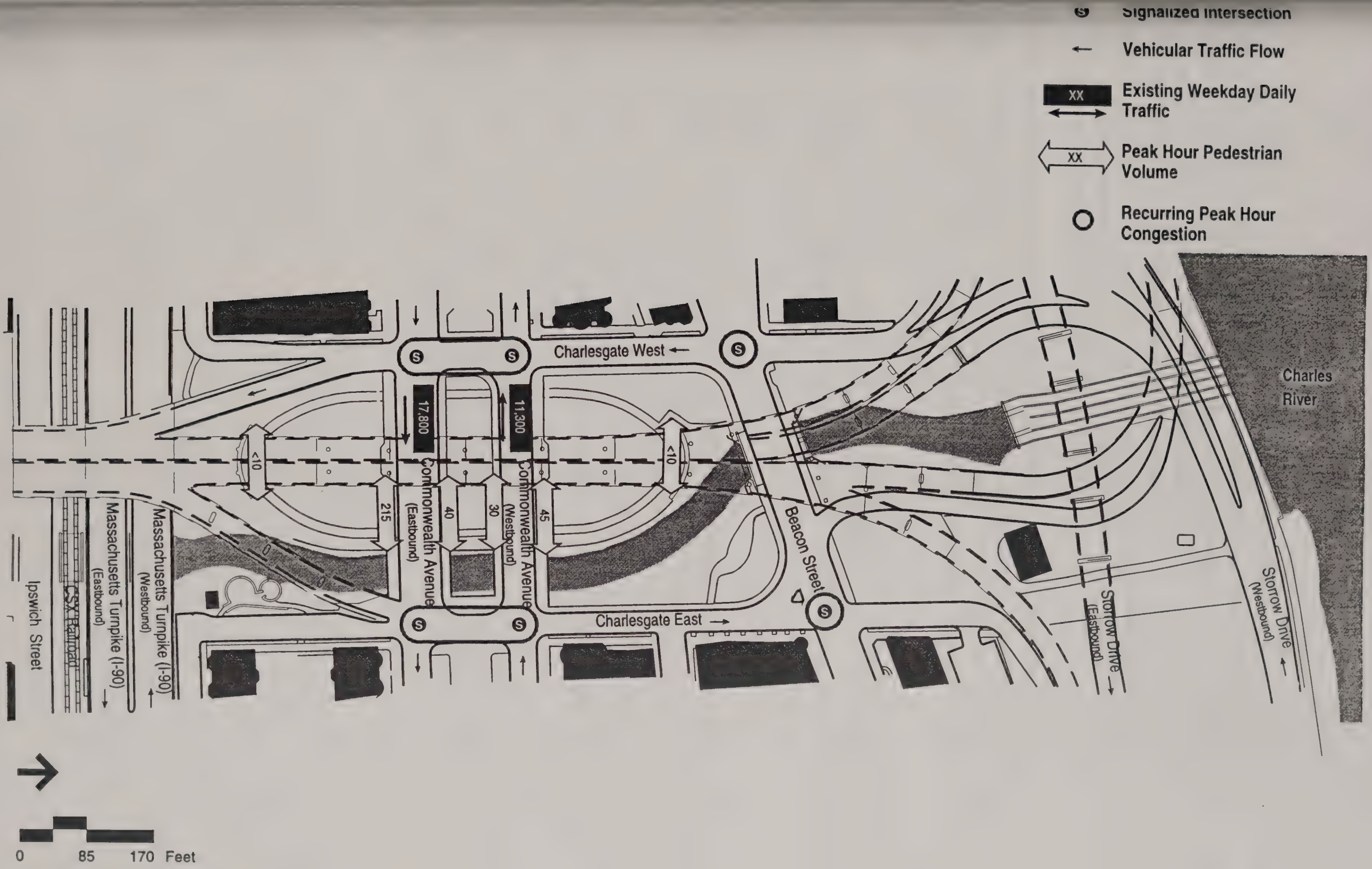
Table 4-5
Pedestrian Volume Summary - Charlesgate Area

Sidewalk	Morning Peak Volume (peds per hour)	Evening Peak Volume (peds per hour)
Commonwealth Avenue eastbound south sidewalk between Charlesgate East and West 130	215	
Commonwealth Avenue eastbound – along the median	40	15
Commonwealth Avenue westbound - north sidewalk between Charlesgate East and West	30	45
Commonwealth Avenue westbound – along the median	20	30
Commonwealth Avenue eastbound – nternal sidewalk to benches	<10	<10
Commonwealth Avenue westbound – nternal sidewalk to benches	<10	<10

Source: Pedestrian counts conducted by VHB in July 2000.

n the morning (approximately 8:00 AM), the peak demand in this area was approximately 130 pedestrians per hour. In the evening (approximately 4:00 PM), the peak pedestrian demand in this area was 215 pedestrians per hour. The lowest pedestrian demands in this area are on the oval internal bricked sidewalks in the area where several concrete benches are located. These volumes were less han 10 pedestrians in the peak hour.

General observations indicate that the pedestrian demands in this area are influenced significantly by Red Sox home games. There is a surge in demand just prior to, and after the ballgame. However, these peak periods do not coincide with a typical construction schedule since most weekday ballgames begin after 7:00 PM. The evening peak hour volumes include a slight increase due to the ballgame from 5:00 PM to 6:00 PM.



Signalized Intersection
Vehicular Traffic Flow
XX
Existing Weekday Daily Traffic
XX
Peak Hour Pedestrian Volume
Recurring Peak Hour Congestion
Charles River
Storrow Drive (Westbound)
Storrow Drive (Eastbound)
Beacon Street
Charlesgate West
Charlesgate East
S
<10
45
11,300
Commonwealth Avenue (Westbound)
30
40
17,800
Commonwealth Avenue (Eastbound)
215
<10
Massachusetts Turnpike (I-90) (Westbound)
Massachusetts Turnpike (I-90) (Eastbound)
CSX Railroad
Ipswich Street
0
85
170 Feet

CDM Camp Dresser & McKee Inc.

mawat\te\06967\graphics\figures\report_formated\6967_1.dwg

Figure 4-17
Muddy River Restoration
Charlesgate Area Existing Traffic Conditions

Source: VHB, Inc.

The existing sidewalk conditions generally are good. The sidewalks that are used more heavily (the southerly sidewalk on Commonwealth Avenue eastbound and the northerly sidewalk on Commonwealth Avenue westbound) are concrete. The sidewalks on Commonwealth Avenue adjacent to the median and the oval path sidewalks are brick. There were no notable pedestrian safety issues that were observed. All sidewalks along Commonwealth Avenue are continuous, wide and in decent condition. Crosswalks are provided and there are pedestrian crossing signals at the intersections in this area. Pedestrians are not given a protected, exclusive crossing phase. Rather, pedestrian crossings are permissive depending on the traffic signal phase.

The volume of pedestrians through this area and the surges in activity are influenced by the proximity of public transit. The Charlesgate area is well served by public transit. The nearest Green Line subway stations are the Hynes Convention Center/ICA Station located at the corner of Massachusetts Avenue and Newbury Street, and the Kenmore Station at Kenmore Square. The MBTA bus routes 1, CT-1, 8, 55, 65, and 67 service this area on adjacent streets.

Counts of bicyclists in the area were conducted concurrently with the pedestrian counts. Although there are no designated bicycle lanes along Commonwealth Avenue, bicyclists frequently share the roadway with vehicles in addition to using the sidewalks. Along Commonwealth Avenue, less than 10 bicyclists per hour were observed.

4.2.4 Traffic

Traffic conditions in the Charlesgate area of this project focus on the intersections of Commonwealth Avenue and Beacon Street with Charlesgate East and Charlesgate West. This area serves traffic headed to and from downtown Boston via Commonwealth Avenue; traffic headed for Storrow Drive; and, raffic headed to the Fenway area via Commonwealth Avenue. The on-ramps to Storrow Drive at Beacon Street are restricted to passenger vehicles only. There is a low clearance on Commonwealth Avenue at the Massachusetts Avenue underpass, causing commercial trucks to use the at-grade ntersection rather than the underpass.

These intersections are congested frequently during morning and evening peak periods. Notable congestion also exists throughout this area just prior to, and after home Red Sox games. Existing traffic volumes in this area were collected on Commonwealth Avenue in July 2000. Table 4-6 and Figure 4-17 provide a summary of the observed traffic volumes.

Table 4-6
Traffic V me Summary - Charlesgate Area

Roadway	Morning Peak Hour Volume (vph) 1	Evening Peak Hour Volume (vph)	Weekday Daily Volume (vpd) 2
Commonwealth Avenue westbound - west of Charlesgate East	540	1,050	11,300
Commonwealth Avenue eastbound - west of Charlesgate East	1,070	1,440	17,800

Source: Traffic counts conducted by VHB in July 2000.
Peak hour volume, expressed in vehicles per hour (vph).
Daily volume, expressed in vehicles per day (vpd).

Commonwealth Avenue westbound carries approximately 11,300 vehicles per day (vpd) and Commonwealth Avenue eastbound carries 17,800 vpd. Traffic on Commonwealth Avenue is predominantly headed eastbound toward the downtown in both the morning and evening peak periods. Peak hour volumes on Commonwealth Avenue eastbound are 1,070 vehicles per hour in the morning and 1,440 vph in the evening. Westbound peak hour volumes are 540 vph in the morning ar 1,050 vph in the evening peak hour.

Because of the heavy peak hour demands along Commonwealth Avenue, congestion occurs at the Charlesgate intersections. The close spacing of these intersections, coupled with heavy left-turns and inadequate vehicle storage, are the cause of the bulk of the traffic issues in this area. Specifically, the queue on Charlesgate East at the Commonwealth Avenue westbound intersection extends through th Commonwealth Avenue eastbound intersection. The left-turns from Commonwealth Avenue eastbound to Charlesgate East are forced to queue along Commonwealth Avenue because of the short spacing on Charlesgate East between traffic signals. This left-turn queue effectively blocks through traffic on Commonwealth Avenue eastbound.

4.3 Back Bay Fens

4.3.1 Physical Environmental Features

The Muddy River flows southeasterly from the Riverway and into that portion of the Emerald Necklace that is referred to as the Back Bay Fens. The Back Bay Fens is located entirely within the Cit of Boston. The Fens is bordered on both sides by linear grassed parkland, and numerous paralleling and intersecting roadways. The Muddy River is paralleled by th DC-maintained Park Drive and The Fenway. The shoreline of the Muddy River along both sides he Back Bay Fens is naturalized landscape. The Back Bay Fens also contains Victory Gardens, th ar Memorial, the Rose Garden an Clemente Field. In close proximity to a number of universities, the Museum of Fine Arts and other cultural attractions, the area is a popular location for active and passive recreation. There are numerous paved and unpaved paths transecting the park.

Extremely dense, large stands of the giant reed grass (*Phragmites australis*) grow along much of the bank and well out into the waterway, severely restricting its flood flow capacity. The Back Bay Fens also contains two sections where the original channel has been culverted and filled over. These areas are located in the former Sears Parking Lot abutting roadways, and the area immediately upstream of the Fens Bridge at Avenue de Louis Pasteur.

As the Muddy River flows from The Riverway section and into the Back Bay Fens area, it passes through the two 6-foot diameter culverts under the former Sears Parking Lot, it passes through a diversion chamber for the Muddy River Diversion Conduit. This conduit, which is located under part of Brookline Avenue, takes higher stormwater flows directly to the Charles River. There is a low flow weir on the Muddy River Diversion Conduit, which allows low flow water to continue into the Back Bay Fens. The Back Bay Fens contains a number of small, individual stormwater outfalls from Park Drive and the Fenway. Larger outfalls that are noteworthy include the overflow from the Stony Brook Conduit at Back Bay Fens Gatehouse No. 1 as well as the Emmanuel Drain overflow.

4.3.1.1 Hydrology

The Back Bay Fens reach of the river extends from the Ipswich Street bridge (RM 0.27) to the Riverway of the former Sears Parking Lot (RM 1.70). The major drains contributing stormwater flow to this reach of the river are the Stony Brook Conduit (via Back Bay Fens Gatehouse No. 1), and the Emmanuel Drain(BWSC drain line). A portion of the Emmanuel drain is discharged into the Upper Fens Pond, with the remaining portion discharging into the Muddy River Conduit (MRC). Additionally, flow from the Muddy River itself can be diverted into the MRC during high flow conditions, as was the case during the October 1996 storm.

The channel widths in Back Bay Fens range anywhere from about 50 to 200 feet (vertical to horizontal) n some locations. This reach is generally low-lying, with very broad side slopes, as much as 1:20 feet y:x) in some locations. The bed elevation at the upstream end of the Upper Fens Pond (RM 1.53) is about 2.0 ft BCB, which continues down to the upstream area of the Back Bay Fens (RM 1.31) where the elevation begins to rise to about 5.0 ft BCB. The bed gradually declines to about elevation 3.0 ft in the area of Ipswich Street.

Similar to all other reaches throughout the Muddy River, the normal water surface during dry-weather n the Back Bay Fens is approximately 8.0 ft (BCB datum), or the elevation of the Charles River. The average flow during dry-weather is generally between 2 to 5 cfs at the downstream portion of this each.

The hydraulic analysis indicates that during the October 1996 storm, the peak flow in the upstream end of the Back Bay Fens (flow under the Riverway) reached about 520 cfs. The resulting peak flow in the downstream portion was about 1030 cfs. Flows contributed from each of the drains during the storm are as follows:

Drain	Drainage Area (Mi²)	Peak Flow(cfs)	Volume(MG)
Stony Brook Conduit	13	690	265
Emmanuel College Drain	0.15	58.7	38.2

In addition, approximately 256 cfs (166 MG) was diverted from the Muddy River into the MRC at the Brookline Avenue Gatehouse. Since the gate at the Brookline Avenue Gatehouse was opened to divert flow into the MRC during the storm, the MRC was severely surcharged, which caused street flooding in the local areas draining to the MRC.

The profile of the maximum water elevations reached during the storm in the Back Bay Fens reach of the river is shown in Figure 4-18. The downstream end (at Ipswich Street) shows the peak elevation at 11.6 ft BCB. The upstream end of the reach, at the Riverway, is shown to be about 18.87 ft BCB, a rise of about 7.27 ft over a 1.44 mile stretch of the Muddy.

The profile shows that there are two major areas of head loss, or areas where flow is impeded causing water elevations to rise. The first major area is the twin 6-ft conduits that convey the Muddy River flow underground from the Upper Fens Pond (~RM 1.42) to the upstream end of the Back Bay Fens (~RM 1.31). During the October 1996 storm, the HGL rose about 1.5 ft from an elevation of 12.1 ft BCB at the downstream end of the conduits to an elevation of 13.61 ft BCB at the upstream end.

The more significant cause of head loss occurs between the Riverway and the upstream end of the Upper Fens Pond. Through this reach, the Muddy River is conveyed underground through the Brookline Gatehouse via a twin set of 6-ft conduits, a 7x9 ft conduit, and another twin set of 6-ft conduits which eventually discharge into the Upper Fens Pond (~RM 1.53). The HGL shows a rise of about 5.26 ft over this stretch of the river from an elevation of 13.61 ft BCB at the downstream end, to an elevation of 18.87 ft BCB at the upstream end (Riverway).

The portion of the Emmanuel Drain that discharges into the Muddy River Conduit actually passes through the 7x9 ft conduit that conveys Muddy River flow under Brookline Avenue. While this constriction does impede Muddy River flow in this culvert, the model simulations indicate that this constriction only adds about 0.3 ft of rise in water elevation in the upstream sections of the Muddy River (Riverway). The primary reason for the head loss through this area results from undersized culverts.

The undersized culverts do not have the capacity required to convey flows such as those observed during the October 1996 storm. The rise in water elevation through the Back Bay Fens, especially around the Brookline Avenue area, is the primary cause of flooding observed in the Riverway section of the Muddy River including the MBTA station at Kenmore Square.

The existing water flow velocity through the Back Bay Fens portion of the Muddy River ranges from less than 0.5 feet per second (fps) downstream of the Back Bay Fens Gate Houses, to over 10 fps in the existing two 6-foot diameter culverts under the former Sears parking lot as shown on Figure 4-19.

4.3.1.2 Sediment Quality

In 1976 10,000 – 15,000 cubic yards of sediment was dredged by hydraulically from the Muddy River in front of the Back bay Fens Gate Houses Nos. 1 and 2. No other historic record of maintenance dredging of the Muddy River in the Back Bay Fens was found.

In order to determine the quality of sediment for the proposed flood control dredging of the Back Bay Fens, borings (Summer 2000) were completed to a maximum depth of fourteen feet below the top of

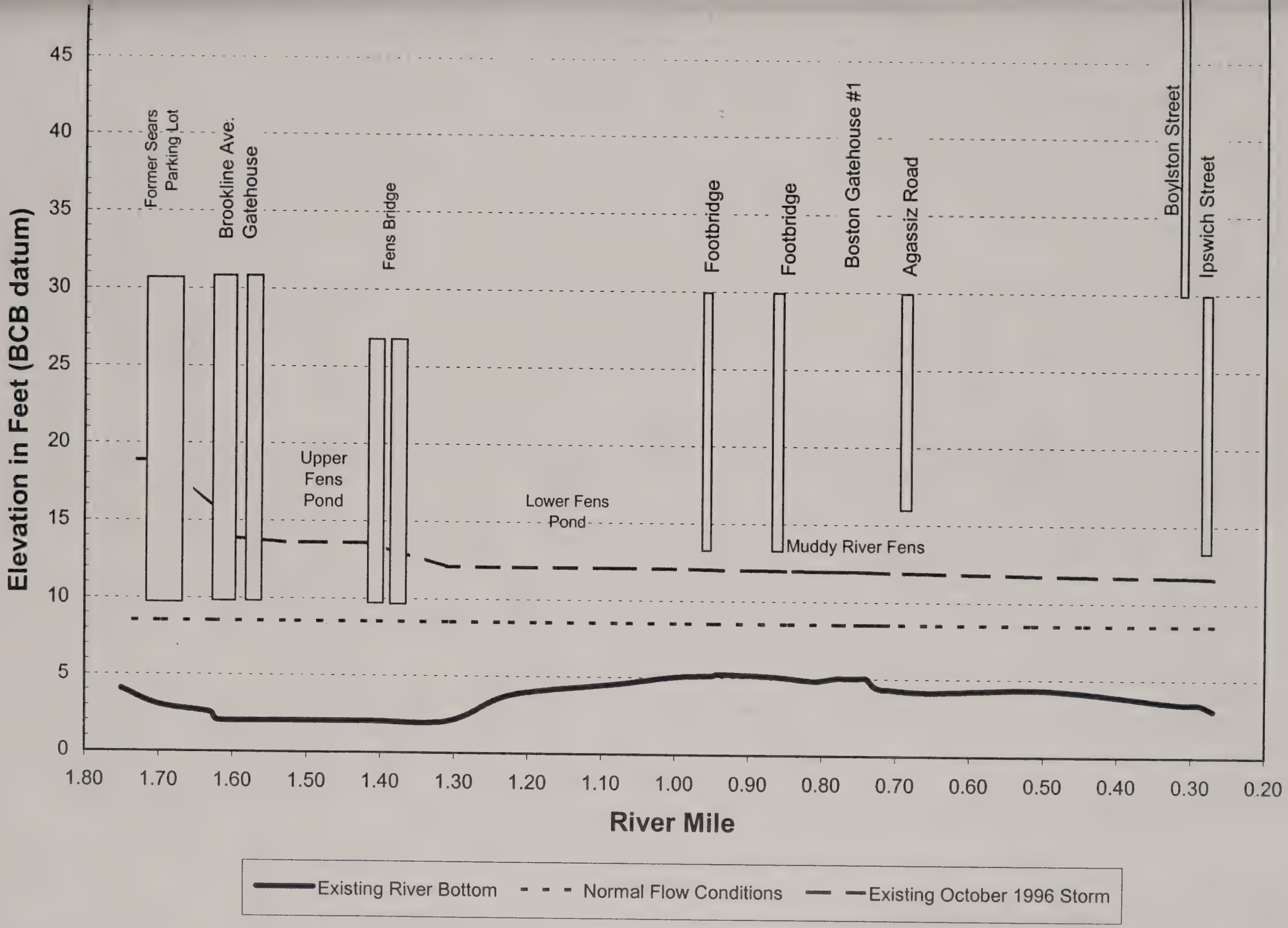


Figure 4-18
Peak Hydraulic Grade Line - October 1996 Storm
Existing Conditions - Back Bay Fens

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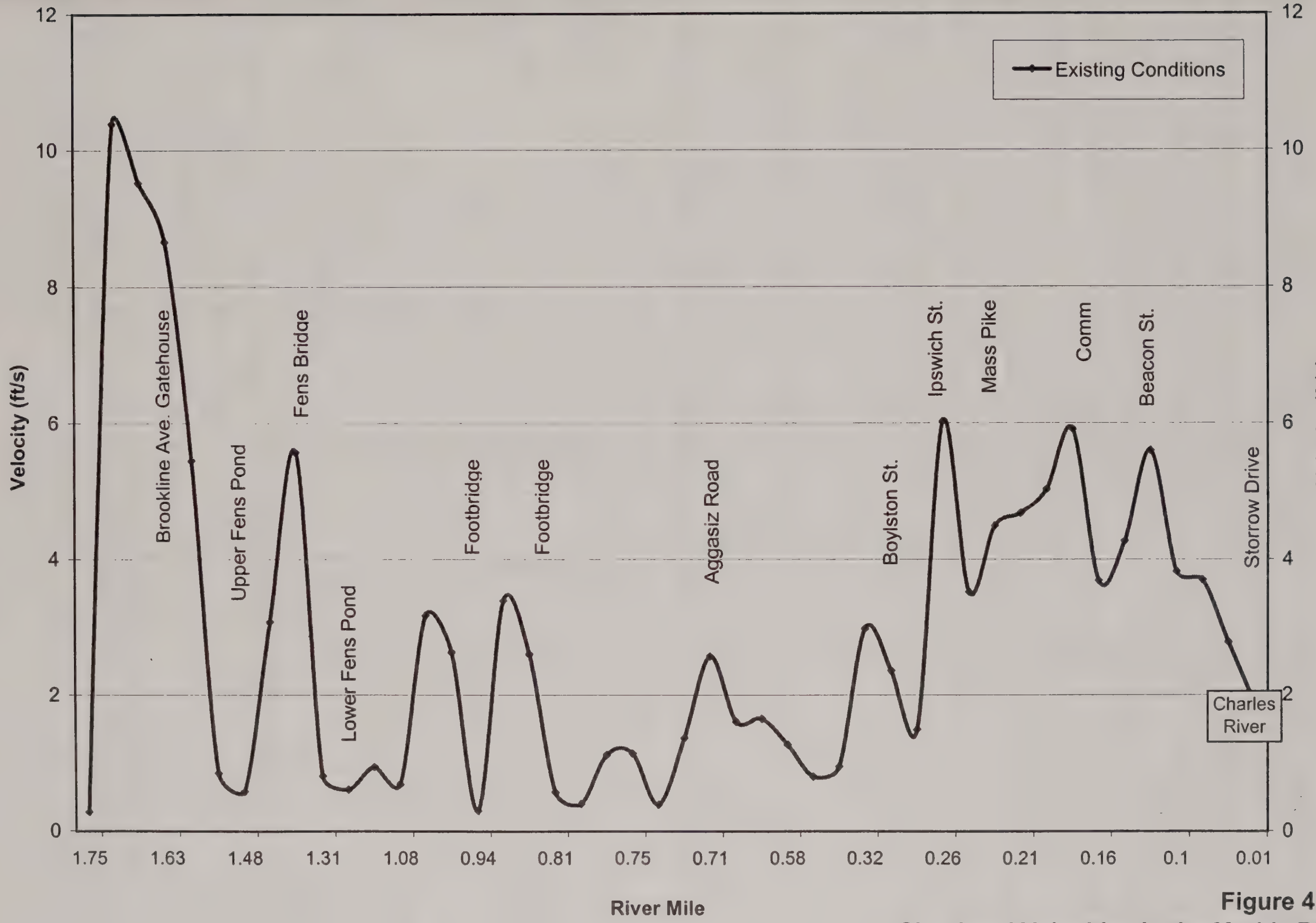


Figure 4- 19
Simulated Velocities in the Muddy River
Downstream of the Riverway
October 1996 Storm

CDM Camp Dresser & McKee Inc.

sediment or until native material was encountered. The general stratigraphy encountered during the advancement of the Back Bay Fens borings consisted of a varying thickness (2 to 12 ft) of a soft, black, organic silt layer, intermixed with fine to coarse sand and gravel. Organic material, consisting of decayed plant matter, sticks, root mass, and peat, was observed in the upper limits (2 to 4 ft) of sediment at several boring locations. The southern limits of the Fens exhibited shallow deposits (0 to 4 ft) of sediment comprised of coarse, grained sand and gravel with little organic material. Within the northern two thirds of the Fens, the depth of the sediment increased to an average depth of seven feet below the top of the sediment. Typically, the deeper deposits of sediment contained finer grained sand and increased organic silt. The native material underlying the organic silt layer was typically observed at 2 to 12 ft below the top of the sediment. Native material consists of grey, loose to dense, fine to medium sand with varying amounts of fine gravel and silt. Petroleum odors were noted at several boring locations within the Back Bay Fens Area. At locations BBF-SED-7, -13, -21, -25, and -48, petroleum odors were noted in surface samples collected from 0 to 2 feet below the top of the sediment. Petroleum odors were noted in samples collected down to eight feet below the top of the sediment from locations BBF-SED-54, -55,-56, -57, -58, -59, and –60. The analytical results for the Back Bay Fens area are summarized in Table 4-7.

able 4-7
ummary of Sediment Analytical Results - Back Bay Fens

Contaminant	No. of Samples	Concentration[1] Minimum	Maximum	DEP Landfill Reuse Levels[1] Unlined	Lined	No. of Samples Exceeding Unlined	Lined
otal Arsenic	169	ND	110	40	40	13	13
otal Cadmium	169	ND	23	30	80	No Exceedances	
otal Chromium	169	7.3	420	1000	1000	No Exceedances	
otal Lead	169	ND	2100	1000	2000	33	2
CLP Lead (mg/L)	82	ND	6.1	NA	NA	9 Exceeds RCRA[2]	
otal Mercury	169	ND	8.9	10	10	No Exceedances	
otal EPH	169	ND	2530	2500	5000	2	None
otal PCBs	162	ND	7.6	<2	<2	16	16
otal PAHs	169	ND	1510	100	100	4	4
otal VPH	169	ND	80	NA	NA	No Exceedances	
otal VPH Target	169	ND	32.1	4	10	1	1
eactive Sulfide	162	ND	1700	500		15	15
eactive Cyanide	162	Not Detected		250		No Exceedances	
H	162	5.7	8	2 < pH < 12.5		No Exceedances	
onductivity	162	69	7200	4000 umhos/cm	8000 umhos/cm	15	None

All results are reported in mg/kg unless otherwise noted.

Concentration above the federal regulatory limit of 5 mg/L.

everal locations from the Agassiz Bridge to Ipswich Street (BBF-SED-45 through BBF-SED-58) xceeded the federal regulatory level for TCLP lead. The concentrations are consistent and range from mg/L to 6.1 mg/L at location BBF-SED-55. This sample was collected from the 6 to 8 ft depth interval and was the only sample of native material that exceeded the regulatory limit. The TCLP result from the surficial sample at this location was 5.5 mg/L.

The other constituent of significance that was detected consistently is arsenic. Concentrations of arsenic above the DEP landfill reuse level of 40 mg/kg were found in samples collected downstream from the Emmanuel Drain overflow to Back Bay Fens Gatehouse No. 1 (BBF-SED-7 through BBF-SED-27). The concentrations ranged from 40 mg/kg to 110 mg/kg at BBF-SED-10. This sample was tested for TCLP and the arsenic result was below the detection limit.

The results of the VPH scan correlated fairly well with observations (i.e., petroleum odors) noted during sample collection. The C_9 to C_{12} aliphatic hydrocarbons were found more frequently than the other carbon ranges and typically at higher concentrations. Toluene was the only target compound found, and at several locations. The concentration of toluene ranged from 0.083 mg/kg to 0.68 mg/kg in samples collected from the 0 to 2 ft and the 2 to 4 ft depth intervals. The results of the EPH scan were below the DEP landfill reuse levels except at location BBF-SED-58. Samples collected from the 0 to 2 ft and 2 to 4 ft depth intervals had concentrations of 2,510 mg/kg and 2,530 mg/kg, respectively. Elevated levels of target PAH compounds were found in a sample collected of native material at location BBF-SED-17. The total PAH concentration was 1,510 mg/kg in the 6 to 8 ft depth interval. Total PAHs above the DEP landfill reuse level of 100 mg/kg were found at locations BBF-SED-31 at a concentration of 138 mg/kg, BBF-SED-37 at a concentration of 145 mg/kg and BBF-SED-57 at a concentration of 112 mg/kg. These samples were collected from the fill material.

Concentrations of PCBs above 2 mg/kg were found in most of the samples collected from the Back Bay Fens Gatehouse No. 1 to Ipswich Street. The concentrations in these samples ranged from 2 mg/kg to 7.6 mg/kg. Only aroclor 1254 and 1260 were found above detectable levels in the samples analyzed. The results of the pesticide analysis show that 4,4′-DDD, 4,4′-DDE and 4,4′-DDT were detected most frequently. The concentrations found were typically below 1 mg/kg with the following exceptions: BBF-SED-27 (4,4′-DDD at 1.2 mg/kg); BBF-SED-43 (4,4′-DDD at 1.5 mg/kg); BBF-SED-50 (4,4′-DDD at 1.8 mg/kg); and BBF-SED-58 (4,4′-DDD at 2.3 mg/kg and 4,4′-DDT at 1.5 mg/kg).

Select samples were also analyzed for nitrates and total phosphorus. Nitrates were not detected and total phosphorus was either not detected or found at low levels.

Reactive sulfide above the regulatory limit was found in 15 samples ranging in concentration from 510 mg/kg to 1,700 mg/kg. Samples from five of the locations also had TCLP lead above the regulatory limit. Eight representative samples were submitted for the paint filter test. The results showed that five of the samples did not have free liquids present and three of the samples did contain free liquids.

The methodology for the sediment test program, analytical results, and summary figures are included in Appendix F.

Elutriate analyses were conducted on sediment from the Back Bay Fens in order to determine, if during the process of hydraulic dredging, if any toxic metals could be released to the environment. The metals that were analyzed included those that are required by the ACOE and the MA DEP, i.e. antimony, arsenic, beryllium, cadmium chromium, copper, lead, mercury, nickel, selenium, silver, thallium, zinc. In the elutriate analysis procedure, sediment is mixed with water at the same general ratio as would occur during hydraulic dredging, i.e. 1 part of sediment to 5 parts of water. The sediment and water are mixed, filtered, and tested. The receiving water is also tested for the same constituents. The difference in concentrations indicate the magnitude of the toxins that could be released during the dredging. The sample location(s) that were selected were done so because the results of the bulk sediment characterization indicated high levels of contamination. An elutriate analysis was conducted on sediment that was collected from the Back Bay Fens between the Victory Gardens and Mothers Rest (sediment sample BBF Sed 55), opposite Boston Gatehouse No. 1 (sediment sample BBF Sed 30), and the Evans Way Footbridge (sediment sample BBF Sed 10). These sediment sample locations are shown on Figure F2-1A and Figure F2-2A in Appendix F. The tests on sediment sample BBF Sed 55 did not result in the release of toxic metal contaminants. The tests on sediment samples BBF Sed 30 and BBF Sed 10 did result in the release of 0.03 mg/l of copper from BBF Sed 30 and 0.016 mg/l of arsenic from BBF Sed 10. The concentration of copper that was released from BBF Sed 30 is above the acute and chronic freshwater water quality criteria of 0.018 mg/l and 0.012 mg/l, respectively. The concentration of arsenic that was released is below the acute and chronic freshwater water quality criteria of 0.360 mg/l and 0.190 mg/l, respectively.

4.3.1.3 Water Quality

While there are a number of smaller stormwater outfalls into the Muddy River from the adjacent parkways, the first notable outfall is Gatehouse No.1 for the Stony Brook Conduit which is Boston's only CSO into the Muddy River. Presently the Stony Brook Conduit overflows into the Muddy River approximately two times per year. The relationship of the Stony Brook Conduit to the Muddy River has been described in section 4.1. The next large outfall is the Emmanuel Drain overflow, which is located just upstream of The Fens Bridge at Avenue de Louis Pasteur.

The Massachusetts Department of Environmental Protection (MA DEP) has established Water Quality Standards for all waters in the Commonwealth. The Muddy River watershed has been classified as Class B waters. As such, Class B waters are considered swimmable and fishable.

In order to assess the water quality of The Back Bay Fens, a review of the water quality history was conducted and along with water also being sampled and analyzed as part of this project. Historical water quality data includes that from the:

Division of Water Pollution Control (now the MA DEP)	1974
Division of Water Pollution Control (now the MA DEP)	1986
Army Corps of Engineers	1992
Northeastern University	1995
Charles River Watershed Association (CRWA)	1998

The historical data indicated that bacteriological, water quality standard (<200 bacteria/100 ml of water) and/or the dissolved oxygen water quality standards (>5mg/1 or>75% of saturation) were not met in 1974, 1986, and 1992. The CRWA did not test for temperature, dissolved oxygen and pH. The water quality of the Back Bay Fens did meet the temperature (<20°C) and pH (6.5-8.3units) standards during these years.

While the Water Quality Standards do not have numeric criteria for suspended solids, nitrogen and phosphorus, certain limnological (the study of freshwater ecology) water quality values can be applied to the Muddy River due primarily because of its lentic (very slow moving) character. These criteria were 20 milligrams per liter (mg/l) for total suspended solids (TSS), 0.30 mg/l for inorganic nitrogen (the summation of nitrate, nitrite, and ammonia nitrogen forms), and 0.01 mg/l for total phosphorus. Applying these values against the historical data, it was noted that there were excessive nutrient conditions in the Back Bay Fens during 1974, 1986, 1992, 1995, and 1998.

Many of the cross connections between sanitary sewers and combined sewers in the Stony Brook and Emmanuel College drainage systems have been corrected and sewer separation work is continuing. There are numerous municipal projects that have either been completed or are in progress to correct the sanitary sewers and storm sewers. These include ongoing work by the BWSC and Brookline for sewer separation, the continuation of Stony Brook Conduit Project, the implementation of the Boston Catch Basin Improvement Project, continuing elimination of illegal cross connections, stormwater management programs, permitting of large sewer users and regulation of industrial discharges, permitting of new or retrofitted building projects through the BWSC's Site Plan Review procedure, other NPDES-related compliance efforts. These programs have resulted in substantial water quality improvements by reducing the very high bacterial contamination that past data show existed. The street sweeping and catch basin cleaning program in both municipalities will be increased. In addition, both municipalities operate used motor oil collection centers and collect hazardous wastes.

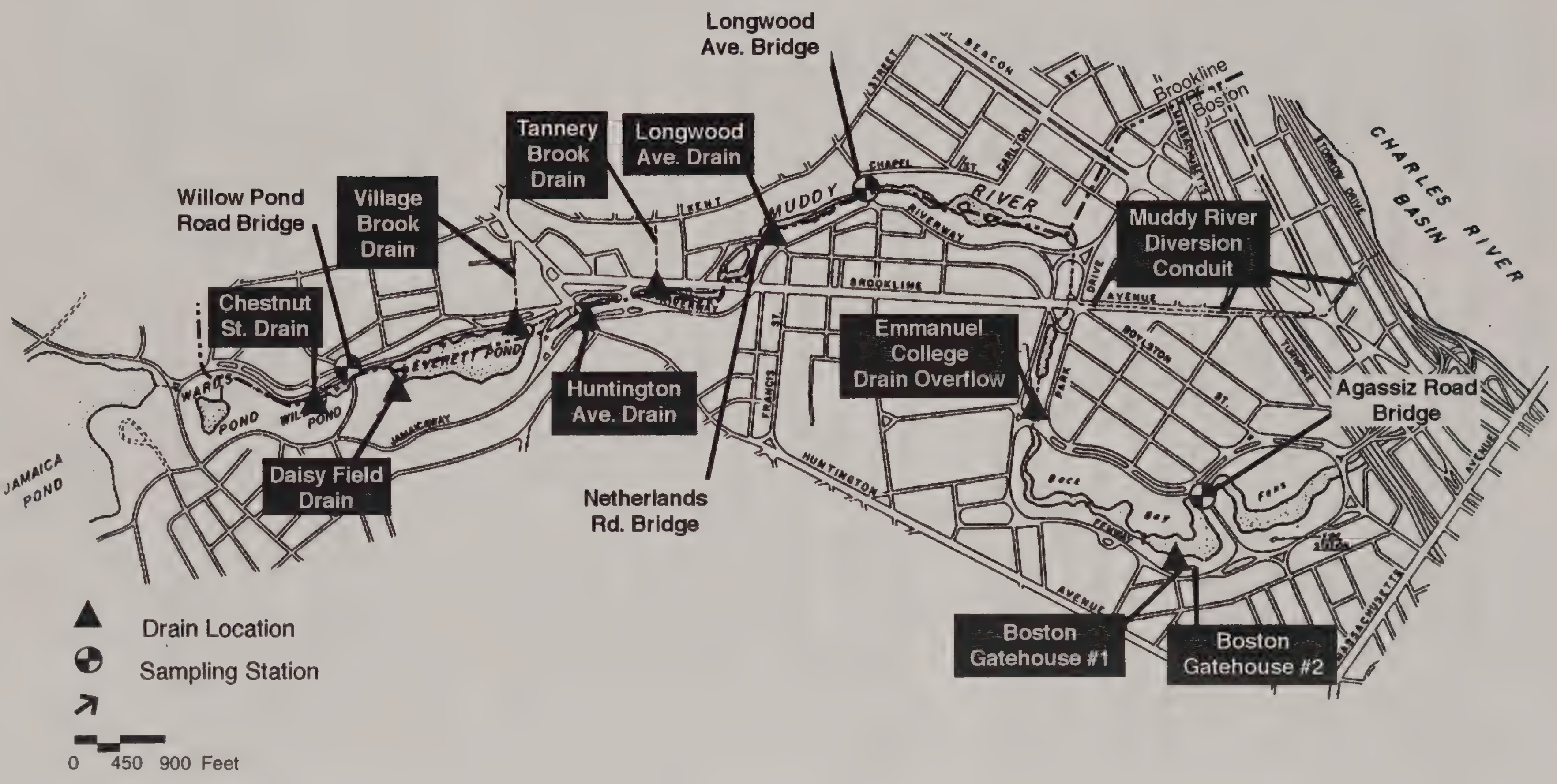
On October 4 (dry weather conditions), October 6 (wet weather conditions, and December 14, 2000 (we weather conditions), the water quality of the Back Bay Fens and associated large discharged outfalls (see Figure 4-20) were analyzed for the following parameters:

Temperature
Dissolved Oxygen (DO)
pH
Turbidity
Total Suspended Solids (TSS)
True and Apparent Color
Nitrate plus Nitrite Nitrogen
Ammonia Nitrogen
Total Phosphorus
Fecal Coliform Bacteria
Fecal Streptococcus Bacteria

The results of the Project's testing of the Muddy River and the outfalls indicated the following water quality conditions during dry and wet conditions.

Water Quality Parameter	**Muddy River at Agassiz Road Bridge**	**Stony Brook Overflow (Boston Gatehouse)**	**Emmanuel College Drain Overflow**
Temperature	P/P/P	P/P/P	N/P/P
Dissolved Oxygen (DO)	P/P/P	P/P/P	N/P/P
pH	P/P/P	P/P/P	N/P/P
Total Suspended Solids (TSS)	P/F/P	P/F/P	N/F/P
Inorganic Nitrogen	F/F/F	F/F/F	N/F/F
Total Phosphorus	F/F/F	F/F/F	N/F/F
Fecal Coliform Bacteria	F/F/P	F/P/P	N/F/P

P - Pass
F - Fail
N - No flow observed
P/F/F - Pass dry weather/Fail wet weather/Fail wet weather
(December 14, 2000)



CDM Camp Dresser & McKee Inc.

Figure 4-20
Muddy River Sampling Stations
Source: BPRD

The water quality report is contained in Appendix G.

At Agassiz Road, the Muddy River was found to contain dissolved oxygen concentrations, as well as oxygen saturation values that were at, or above, the water quality standards of 5.0 mg/l and >75% saturation during dry and wet weather conditions. The pH of the Muddy River was found to be more alkaline during dry weather, possibly due to algae growth. The pH decreased during wet weather conditions, most likely attributable to the low pH of the rainfall and associated runoff. The water was moderately well buffered against rapid changes during the dry and wet weather sampling events. Turbidity and total suspended solids were considerably lower during the dry weather than the wet weather conditions. The color values suggested there were some dissolved humic materials in the water. The nutrient content of the water was found to be higher during wet weather than during dry conditions with total phosphorus levels being five time higher under wet weather conditions. The fecal coliform bacteria exceeded the water quality standard of 200 colonies per 100 ml of water during both dry and wet weather conditions, with the higher concentration being found under wet conditions. In keeping with EPA guidance, the Massachusetts Department of Environmental Protection is developing guidelines for nutrient limitations where the technology based point and non-point source pollution controls are not stringent enough to meet the water quality standards. These guidelines are planned to be issued in 2003.

No water was observed flowing from the Back Bay Fens Gathouses during the sampling due to the lower intensity of the storms. Water in the Muddy River was sampled adjacent and downstream of Gatehouse No. 1 instead. This water was found to meet the dissolved oxygen water quality standard. It had a slightly alkaline pH and was moderately well buffered during both dry and wet weather conditions. The turbidity and total suspended solids concentrations also were low during both sampling events. Although they were above the limnological nutrient standards that were discussed above, the inorganic nitrogen and total phosphorus concentrations were low relative to the concentrations that were detected in the Muddy River itself during the dry and wet weather sampling events. During dry weather conditions, the fecal coliform bacteria did not meet the water quality standard of 200 colonies per 100ml at 300 colonies per 100ml. In keeping with EPA guidance, the Massachusetts Department of Environmental Protection is developing guidelines for nutrient limitations where the technology based point and non-point source pollution controls are not stringent enough to meet the water quality standards. These guidelines are planned to be issued in 2003.

No water flow was observed in the Emmanuel Drain during dry weather conditions. During wet weather, water in the drain was found to meet the dissolved oxygen water quality standard. The water had a slightly alkaline pH and was also slightly buffered. The turbidity and total suspended solids concentrations were elevated during wet weather. The inorganic nitrogen and total phosphorus concentrations were substantially above the limnological standards discussed above during the wet weather-sampling event. The fecal coliform bacteria were an order of magnitude above the water quality standard during the wet weather conditions. Floating debris, algal mats, foam and other floatables are visible in the river. This detracts from the aesthetic quality of the water. The reference to nutrient guideline concentrations will be changed upon the EPA's publication of its regional criteria. This is expected in early July 2001.

4.3.2 Biological Environment

The Back Bay Fens is a maintained urban park with extensive lawns, mature trees, and some shrubs. Monotypic stands of *Phragmites australis* dominate much of the shoreline of the Fens and the plant grows to heights of 18-20 feet. The *Phragmites australis* also is growing out into the waterway to such an extent that it currently severely constricts the flow of water and storage capacity. The following sections include information on the existing woodlands, horticultural resources and aquatic and wildlife resources and wetlands along the Back Bay Fens section of the Muddy River.

4.3.2.1 Upland Vegetation and Horticultural Resources

The inventory, documentation, and analysis of vegetation in the Back Bay Fens Area were completed in August of 2000. The area includes the watercourse from the Boylston Street Bridge (Richardson Bridge) to the Riverway at Sears Parking Lot. The scope of work includes trees, shrubs, vines, and lawn areas including notation of areas of bare lawn and areas of erosion.

Vegetation breakdown under trees includes:
Deciduous trees - indicating species, caliper and condition
Evergreen trees - indicating species, caliper and condition
Woodland

Vegetation breakdown under shrubs includes:
Restored planting with five years of restoration
Shrub massings
Invasive plant colony and indicating species

Erosion includes:
Bare lawn
Washouts of storm sewers
Desire lines
Overuse compaction
Surface roots of trees

Analysis of Existing Vegetation is contained in Table 4-8.

Table 4-8
Inventory and Analysis of Existing Vegetation - Back Bay Fens

Category	Unit	Total	Good	Fair	Poor	Dead
Trees:						
Canopy tree	each	1,223	251	802	165	5
Flowering tree	each	180	17	134	25	4
Evergreen tree	each	12	1	11	0	0
Heritage tree	each	88	21	56	11	0
Total Trees:		**1,503**	**290**	**1,003**	**201**	**9**
Shrubs:	(Estimated)					
Restored planting	square footage	0				
Shrub massing	square footage	26,666				
Total Shrubs:		**26,666**				
Invasive Plant Colonies:	(Estimated)					
Phragmites	square footage	358,382				
Other Invasives (e.g.Knotweed	square footage	26,536				
Total Invasive Plant Colonies:		**384,918**				
Woodland:	(Estimated)					
	square footage	0				

[1] Note: A heritage tree is a canopy tree with a 32" or greater caliper. If it is listed as a heritage tree, it will not be listed as a canopy tree.

accordance with the MA Department of Environmental Management standards, trees that are 32" ches in caliper and over are considered to be heritage trees. All trees have their species and caliper ze identified and the condition of the heritage trees is rated as good, fair or poor as are all other trees the site. The diameter of the circle for tree canopy is in relation to its caliper size.

an documentation is contained in the Appendices in the form of annotated Existing Conditions Plans.

3.2.2 Aquatic and Wildlife Resources

nder normal flow conditions, the Back Bay Fens exists as a slow moving stream ranging in width om less than 20 feet at the Fens bridge to more than 100 feet behind the Victory Gardens. Because of e watershed's developed and impervious nature, the volume of base flow is very low, resulting in most stagnant conditions during prolonged dry periods. The mean annual flow is calculated to be 8 bic feet per second (cfs) and the low flow volume is <0.05 cfs.

though shade trees are prevalent, Back Bay Fens water is warm. The wider parts of the Muddy River the Back Bay Fens are not shaded. Lack of shade combined with very shallow water, resulting from tation and the growth of submerged aquatic vegetation, promotes additional heating of the water. gae growth and suspended sediments cause turbidity in the Back Bay Fens. Existing biological sources data were reviewed including that from the ACOE (US Army Corps of Engineers, Appendix

D, July 1996) and information contained in the Wildlife Habitat Evaluation and Vegetation Assessment of The Back Bay Fens conducted for this project (see Appendix D).

Benthic Aquatic Resources

Aquatic benthic resources consist of those organisms that, through part or all of their life cycles, inhabit the bottom of the resource area. Due to their long-term contact with the bottom sediments and water, the benthic community typically reflects the chemical quality of the sediments and water. The benthic organisms range from those that are pollution intolerant and which inhabit only the cleanest of bottom deposits, to pollution tolerant species which inhabit contaminated sediments. Depending on water and sediment quality, the benthic community in ponds or slow moving waterways may consist of various species of fly larvae (e.g. true flies, caddisflies, May flies, stoneflies, dragonflies, etc.), worms, leeches, various species of crustaceans, snails and other species. The benthic community serves as a food source for such bottom feeding fish as the carp, suckers and goldfish, and smaller forage fish species. Ducks and geese also feed upon these organisms.

The surface sediment in The Back Bay Fens (see Section 4.3.1.2 – Sediment Quality) was found to contain high concentrations of petroleum hydrocarbons, polynuclear aromatic hydrocarbons and heavy metals. The sediment in the Back Bay Fens was found to contain Polychlorinated biphenyls (PCBs) and DDT. In addition, arsenic and lead concentrations were high with lead failing the Toxicity Characteristic Leaching Procedure (TCLP) regulatory standard test for hazardous materials.

The ACOE's benthic analysis of The Back Bay Fens sediment indicated a somewhat different species composition than from the upstream Riverway benthic community. The ACOE sampled the benthic community adjacent to the Back Bay Fens Gatehouses finding 13 species. Adjacent to the Victory Gardens 23 species were present. The benthic community was found to be co-dominated by pollution tolerant tubifid worms and midges (fly larvae). Other pollution tolerant species also were found. The following is a summary of the species that were located in The Back Bay Fens.

Arthropods
- Insects
  - Midges (fly larvae)
  - *Gerris sp.* (water strider)
  - Dragonfly
  - Damselfly

Annelids
- Tubificid Worms
- Leeches

Molluscs
- *Physa* and other snail species
- Freshwater clam species

Aquatic vegetation observed in The Back Bay Fens includes fanwort (*Cabomba caroliniana*), Pickerelweed (*Pontederia cordata*), duckweed (*Lemna minor*), water meal (*Wolffia*), and filamentous algae.

The ACOE also conducted testing of the sediment from The Back Bay Fens to determine its bio-toxicity. The test results indicated that there is a significant impact on the survival of the amphipod (a bottom dwelling organism) test species. There also was a significant impact on the survival of the test fish species, the fathead minnow.

Fish Resources

Information on fish resources in The Back Bay Fens is available from the ACOE data (US Army Corps of Engineers, Appendix D, July 1996) from sampling conducted as part of the Wildlife Habitat Evaluation and Vegetation Assessment (see Appendix D). The fish found in The Back Bay Fens include the following:

Large Mouth Bass	*Micropterus salmoides*
Pickerel	*Esox sp.*
Yellow perch	*Perca flavascens*
Bluegill	*Lepomis macrochirus*
Pumpkinseed	*Lipomis gibbosus*
American eel	*Anguilla rostrata*
Common Shiner	*Notropis cornutus*
Golden shiner	*Notemigonus crysoleucas*
Goldfish	*Carassius sp.*
Common carp	*Cyprinus carpio*

In 1990, the Massachusetts Division of Fisheries and Wildlife conducted PCB analyses on the tissue of fish that had been collected from The Riverway and The Back Bay Fens. The tests indicated that PCBs were contained in the edible tissue of the fish above the USDA Action Level. A Public Health Advisory was issued.

Wildlife Resources

The wildlife resources of The Back Bay Fens include avian and non-avian species, noted through on-site observations conducted as part of the Wildlife Habitat Evaluation and Vegetation Assessment (see Appendix D). Observed wildlife species at and around, the Back Bay Fens include the following:

Birds

American Crow	*Corvus brachyrhynchos*
American Robin	*Turdus migratorius*
Black-capped Chickadee	*Parus atricapillus*
Blue Jay	*Cyanocitta cristata*
Common Grackle	*Quiscalus quiscula*
European Starling	*Sturnus vulgaris*
Gray Catbird	*Dumetella carolinensis*
Great Blue Heron	*Ardea herodias*
Green Heron	*Butorides v. virescens*
Herring Gull	*Laurs argentatus*
House sparrow	*Passer domesticus*
Mallard	*Anas platyrhynchos*
Red-winged Blackbird	*Agelaius phoeniceus*
Rock Dove	*Columba livia*
Song Sparrow	*Melospiza melodia*
Sparrow Hawk	*Falco sparvaniens*
Tree Swallow	*Tachycineta bicolor*
Tufted Titmouse	*Parus bicolor*
Common Yellowthroat	*Geothylpis trichas*

Reptiles

Common Musk Turtle	*Sternothaerus odoratus*
Red Eared Slider	*Chrysemys scripta*

4.3.2.3 Rare Species

The Massachusetts Natural Heritage and Endangered Species Program was consulted (see Appendix K). Endangered, threatened, rare species are not reported to inhabit The Back Bay Fens.

4.3.2.4 Wetland Resources

The wetland resources at The Back Bay Fens were delineated during the spring and summer of 2000. An Abbreviated Notice of Resource Area Delineation (ANRAD), which contained the wetland delineation plans, was presented to the Boston and Brookline Conservation Commissions and accepted by both Commissions in September 2000. A description of the methodology that was used to delineate the wetlands around The Back Bay Fens is provided in Appendix B.

The wetland delineation at The Back Bay Fens resulted in the following resource area findings:

Bank	13,540 lf
Land Under Water	745,228 sf
Vegetation growing in Land Under Water	194,783 sf
Bordering Vegetated Wetland	15,682 sf

The following wetland plants were found to inhabit The Back Bay Fens and its adjacent areas.

giant reed grass	*Phragmites australis*
glossy buckthorn	*Rhamnus frangula*
northern arrowwood	*Viburnum regnium*
red maple	*Acer rubrum*
purple loosestrife	*Lythrum salicaria*
cattails	*Typhia Latifolia*

4.3.2.5 Ecological Functions and Values

An Ecological Functions and Values analysis was conducted by following the US Army Corps of Engineers Highway Methodology (Supplement, November 1995). The purpose of the Functions and Values analysis is to provide as non-biased an assessment of the habitat and wildlife as possible. The results of the Functions and Values Assessment for the Back Bay Fens are shown in Table 4-9.

The Back Bay Fens extends from the former Sears Parking Lot to the Charlesgate Area. The Back Bay Fens is used intensively by the public due to the wide flanks of parkland adjacent to the river. The area is intensely manicured and landscaped and contains [illegible] memorial, a ballfield and playground, a rose garden and an expansive community garden known [illegible] Victory Gardens. The dominant vegetation within this area is giant reed grass (*Phragmites austra*[illegible] which occupies in excess of 5-acres of the watercourse. The extent and density of *Phragmites* screens park vistas from footbridges and road bridges.

Wetland Function-Value Evaluation Form

Total area of wetland______Human made?____Is wetland part of a wildlife corridor?___________or a "habitat island"?

Adjacent land use_Park____________________Distance to nearest roadway or other development________________

Dominant wetland systems emergent Contiguous underdeveloped buffer zone present___NI_________

Is the wetland a separate hydraulic system?__No_________If not, where does the wetland lie in the drainage basin?______

How many tributaries contribute to the wetland?___1______Wildlife & vegetation diversity/abundance (see attached list)

Wetland I.D.
Latitude______Longitude________
Prepared by:___JLG__Date_10/19/00
Wetland Impact:
Type_______________Area________
Evaluation based on:
Office__X__________Field______
Corps manual wetland delineation completed? Yes X____No_______

Function/Value	Occurrence		Rationale (Reference #)*	Principal Function(s)/Value(s)	Comments
	Y	N			
Groundwater Recharge/Discharge		X	7,8		No evidence of groundwater discharge.
Floodflow Alteration	X		4,5,6,8,10,12,13,18	X	Wetland is able to retain some flood water.
Fish and Shellfish Habitat	X		4,6,7,12,14,17		Fish are present.
Sediment/Toxicant Retention	X		1, 4,9,10,14,15,16	X	Wetland is effective in trapping sediments from runoff waters.
Nutrient Removal	X		2,3,4,6,7,8,9,15	X	Wetland is able to trap nutrients from surrounding uplands.
Production Export		X	2,7		Wetland contains little useable food for living organisms
Sediment/Shoreline Stabilization	X		3,4,8,9,12,13		Phragmities are effective in stabilizing the bank.
Wildlife Habitat		X	13		Mono-ecosystem, does not provide a diversity for wildlife habitat.
Recreation	X		1,4,10,11,12		Area is used for passive recreation.
Educational Scientific Value		X	12		Area is not used for educational value
Uniqueness/Heritage		X			
Visual Quality/Aesthetics		X			
ES Endangered Species Habitat		X			No endangered species reported in the area
Other					

*Refer to back up list of numbered considerations.

Notes: *=Restoration goals are designed to provide and enhance these functions and values

Table 4-9
Wetland Function-Value Evaluation Form for Back Bay Fens

The 13 functions and values that are considered by the Regulatory Division for any Section 404 wetland permit are listed below. The list includes eight functions and five values. Values are grouped together at the end of the list.

These are not necessarily the only wetland functions and values possible. Not are they so precisely defined as to be unalterable. However, they do represent the best working 'palette' of descriptors, which can be used to paint an objective representation of the wetland resources associated with a proposed project.

Groundwater Recharge/Discharge--This function considers the potential for a wetland to serve as a groundwater recharge and/or discharge area. Recharge should relate to the potential for the wetland to contribute water to an aquifer. Discharge should relate to the potential for the wetland to serve as an area where groundwater can be discharged to the surface.

Floodflow Alteration (Storage & Desynchronization)--This function considers the effectiveness of the wetland in reducing flood damage by attenuation of floodwaters for prolonged periods following precipitation events.

Fish and Shellfish Habitat--This function considers the effectiveness of seasonal or permanent waterbodies associated with the wetland in question for fish and shellfish habitat.

Sediment/Toxicant/Pathogen Retention--This function reduces or prevents degradation of water quality. It relates to the effectiveness of the wetland as a trap for sediments, toxicants or pathogens.

Nutrient Removal/Retention/Transformation--This function relates to the effectiveness of the wetland to prevent adverse effects of excess nutrients entering aquifers or surface waters such as ponds, lakes, streams, rivers, or estuaries.

Product Export (Nutrient)--This function relates to the effectiveness of the wetland to produce food or usable products for human, or other living organisms.

Sediment/Shoreline Stabilization--This function relates to the effectiveness of the wetland to stabilize stream banks and shorelines against erosion.

Wildlife Habitat--This function relates to the effectiveness of the wetland to provide habitat for various types and populations of animals typically associated with wetlands and the wetland edge. Both resident and/or migrating species must be considered. Species lists of observed and potential animals should be included in the wetland assessment report.

Recreation (Consumptive and Non-Consumptive)--This value considers the effectiveness of the wetland and associated watercourses to provide recreational opportunities such as canoeing, boating, fishing, hunting and other active or passive recreational activities. Consumptive opportunities consume or diminish the plants, animals, or other resources that are intrinsic to the wetland, whereas non-consumptive opportunities do not.

Education/Scientific Value--This value considers the effectiveness of the wetland as a site for an 'outdoor classroom' or as a location for scientific research or study.

Uniqueness/Heritage--This value considers the effectiveness of the wetland or its associated waterbodies to produce certain special values. Special values may include such things as archeological sites, unusual aesthetic quality, historical events, or unique plants, animals, or geological features.

Visual Quality/Aesthetics--This value relates to the visual and aesthetic qualities of the wetland.

ES **Threatened or Endangered Species Habitat**---This value considers the effectiveness of the wetland or its associated waterbodies to support threatened or endangered species.

Source: ACOE

At the Back Bay Yard, the river is directed through two subterranean culverts. The river daylights approximately 0.14 mi. southeast of the Sears Parking Lot. Upon daylighting, the river appears as a linear pond and flow is directed through culverts just a short distance downstream at Avenue de Louis Pasteur. The mature canopy in this area provides some wildlife habitat with mature canopy vegetation and numerous basking and perching sites within the watercourse.

The mature canopy consists of river birch (*Betula nigra*), paper birch (*Betula papyrifera*), northern red oak (*Quercus rubra*), pin oak (*Quercus palustris*), black oak (*Quercus velutina*), silver maple *(Acer saccharinum*), and norway maple (*Acer platanoides).* The shrub community is dominated by glossy buckthorn (*Rhamnus frangula*), with scattered individuals of arrowwood (*Viburnum dentatum)* and honeysuckle. Southeast of Avenue de Louis Pastuer, there are two sizable patches of *Phragmites.*

At Clemente Field the river flows northeast towards the Charlesgate Area. Canopy vegetation is comprised of pin oak (*Quercus palustris*), black oak (*Quercus veluntina*), northern red oak *(Quercus rubra*) and weeping willow (*Salix babylonica*), arrow wood (*Viburnum dentatum*), and glossy buckthorn (*Rhamnus frangula*). Blue flag (*Iris versicolor*) and tartarian honeysuckle (*Lonicera tatarica*) are also present. Patches of *Phragmitmites* appear throughout.

The lagoon directly opposite the Museum of Fine Arts is one of the few hard-bottom areas within the Back Bay Fens. The hard bottom provides wildlife habitat for fish species such as common carp (*Cyprinus carpio*), punkinseed sunfish (*Lepomis gibbosus*) and bluegill sunfish (*Lepomis manrochirus*). Vegetation around the lagoon is dominated by purple loosestrife (*Lythrum salicaria*), false indigo (*Amorpha fruticosa*), and hawthorns.

Principal wetland functions throughout the Back Bay Fens include sediment and floodflow alteration, fish and shellfish habitat, sediment/toxicant retention, nutrient removal, production export, and sediment/shoreline stabilization.

4.3.3 Cultural Environment

4.3.3.1 Historic Resources

The Back Bay Fens has a Primary Period of Significance of 1878-1895, which is the time of Frederick Law Olmsted's design of the park in that area, and its construction. Plans and working drawings in the archives of the Olmsted National Historic Site (FLONHS) document the development of the park by the Olmsted firm during this period. The most significant of these are the published plans, "Proposed Improvement of Back Bay" (1879), "Map of the Back Bay Fens, Commonwealth Avenue, Beacon Street and Audubon Road" (1887), and "Plan of Portion of Park System from Common to Franklin Park (1896). Numerous nautical charts and an 1878 survey in the archives of the Olmsted National Historic Site titled "Topographic Plan for Back Bay Fens showing Gravely Point" show that virtually all of the islands and peninsulas within the basins of the Fens were created by dredging according to Olmsted's plans. A survey of 1921 documents the Olmsted as-built design, as well as showing where filling of the Fens had occurred in the intervening period.

The 1879 design illustrates a winding stream flowing through a salt marsh. In fact, Olmsted's design intent was to create the feeling of a restored natural salt marsh, but he also introduced a wider variety of plant species than would have grown naturally in the area (see Figure 4-21).

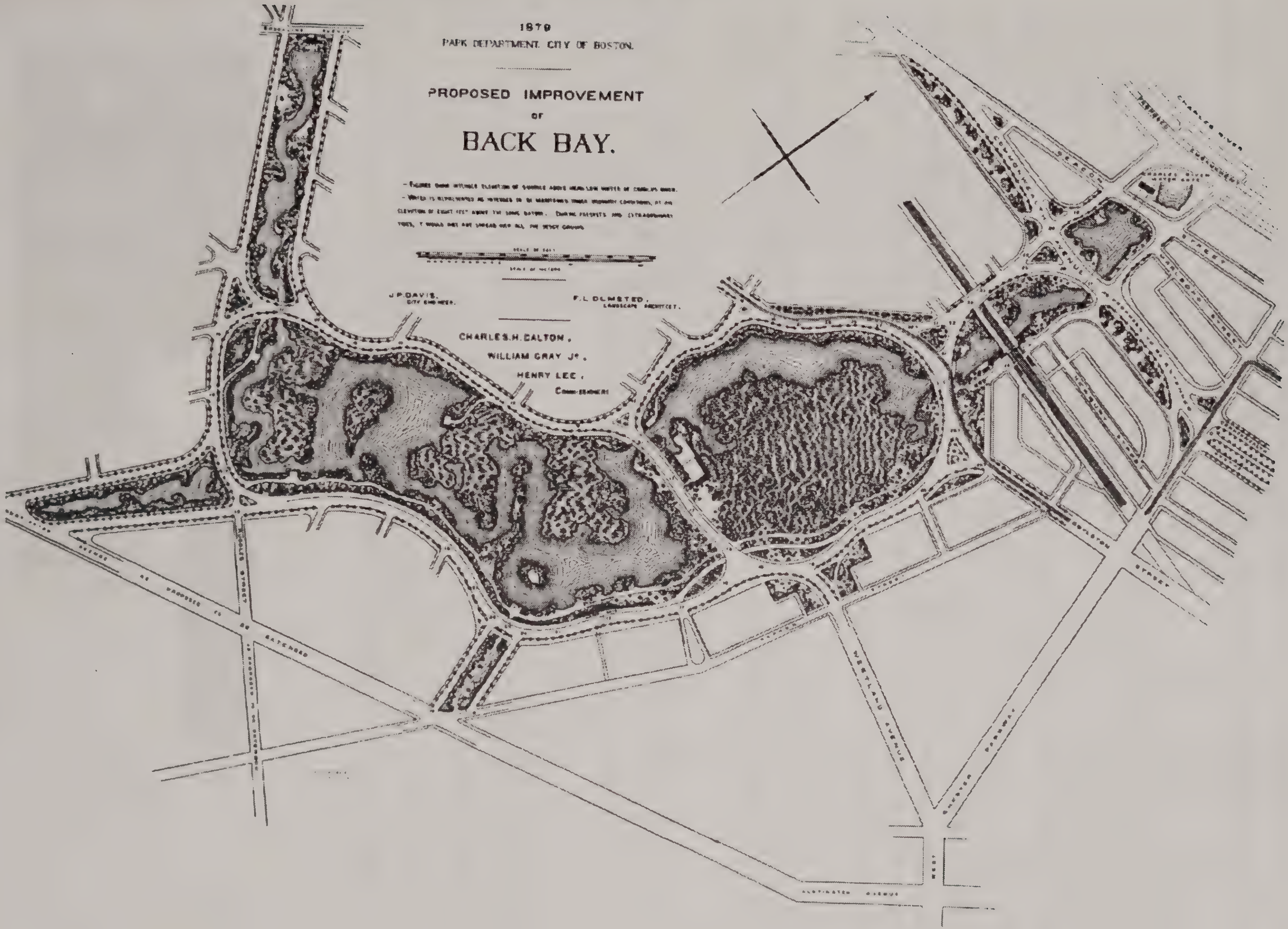


Figure 4-21
Proposed Improvement of Back Bay, 1879
Source: FLONHS

As Olmsted explained in his "Paper on the Back Bay Problem and Its Solution" of 1886, he planned the naturalistic landscape of the public park in the Fens as an alternative to the traditional stone-lined holding basin by which similar problems of sewerage and storm-water control were solved elsewhere. (See the Papers of Frederick Law Olmsted, Supplementary Series, Volume 1, pp. 437-59.)

> *"The landscape created according to Olmsted's plans was that of a salt marsh of the region, although he used a wider variety of plants than would have grown naturally in the area. In addition to islands and peninsulas that rose up to four feet above the high tide level, Olmsted planned the landscape with extensive low islands planted with sedge that, in addition to their scenic purpose, were intended to prevent development of surf that would undercut the banks during times of high winds and heavy rain when the floodwaters of Stone Brook would be diverted into the Fens basin. The narrow, curving waterway, in addition to providing landscape interest, provided no place where storm winds could build up heavy surf. Olmsted's plan also included a complex circulation system of drives, walks and bridle paths that would make the landscape accessible to a variety of users. While conceiving the recreational purpose of the area to be primarily the enjoyment of the salt-marsh scenery, Olmsted also provided for boating, including a circuit for large launches serving as public water buses. He also proposed that the park serve a scientific purpose, as a site for a collection of aquatic birds and fish.*
>
> *Thus the Back Bay Fens was designed and constructed to serve a variety of recreational and educational purposes, while at the same time solving difficult and serious problems of sanitary engineering."*

It was in fact a designed "naturalistic" landscape very different from the tidal flats that were the natural condition of the site when Olmsted began his work. The 1911 "Thirty-Sixth Annual Report, Board of Commissioners, Department of Parks Boston, Massachusetts" includes the following quote by Frederick Law Olmsted, Jr.

"The landscape design of the Fens was to create a salt creek bordered by salt marshes enclosed by high banks intended to be covered with wild flowers, low compact shrubs, vines and creepers, and scattering trees enough with the street trees to fairly well screen the future adjoining houses, but not enough to unduly shade out the ground cover. There are to be found many examples of this type of landscape where the little freshwater rivers of New England come to the sea level and mingle with keen delight by artists and lovers of natural scenery, but probably never before conceived of as a thing to be imitated in laying out a public park." (See Figure 4-22)

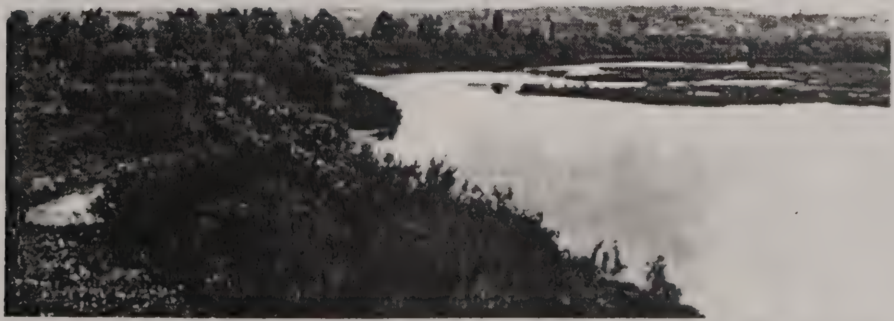


Figure 4-22
View of Back Bay as a Tidal Basin, 1890's
Source: Frances Loeb Library HASD

Photographic documentation for this period, and some documentation from planting plans for the northern basin, by W.L. Fischer, c. 1885, and plant lists exist. The plant lists principally include trees, although thick plantings of shrubs in both the northern and southern basin can be seen in both the photographic documentation and extensive marsh grasses. Plants that were believed to be salt-tolerant were selected.

Three bridges were included in the design, the Boylston Street and, Agassiz Road Bridges for street traffic, and the Fens Bridge (at Avenue Louis Pasteur/Higginson Circle) for foot traffic. Olmsted also introduced a sewer interceptor and associated gatehouse to control stormwater runoff from Stony Brook into the Fens. The gatehouse and conduit were completed in 1882. In 1883 the Muddy River Conduit to the Charles River at Charlesgate was introduced. The 1887 lithograph of the Olmsted plan illustrates the park as completed by Olmsted (See Figure 4-23).

In 1886 Stony Brook flooded 63 acres of lower Roxbury causing extensive damage. As a result, by 1897 the New Stony Brook Conduit (The Commission's Channel) was constructed, bringing pollution into The Fens basin, which resulted in offensive conditions. In 1989, the Fens was dredged to removed sludge deposits and foul odors. In 1903 The Commissioner's Channel was extended, a second Gatehouse was constructed and the 1882 Gatehouse was relocated.

The 1921 survey documents the grading and the shrub and tree massings from the Olmsted Period. It also shows the 1900 to 1920 gradual filling of the marshes under Commissioner John Pettigrew. In 1908, fill materials from subway excavations in Boston were dumped and graded in the Fens for ball fields. Pressure to provide spaces for organized active sports and for playgrounds and the need to find a place to dump excavation material resulted in further filling. This survey and other historical plans allow us to determine the line of the shore by the end of the Olmsted Period, as well as plant massings on the shoreline.

The Secondary Period of Significance is 1910-1933, during which Arthur A. Shurtleff redesigned much of the area. In addition to extensive filling of the basins, the water changed from salt to fresh, facilities for recreation were introduced into the landscape, along with ornamental gardening in the form of the James Michael Curley Rose Garden, and non-recreational functions such as the Fire Control Center.

Shurtleff, hired as a landscape consultant in 1910, prepared a Revised General Plan in 1921 in consultation with Olmsted Brothers. The plan illustrates a meandering fresh water river, which appears to be similar to Olmsted Senior's design for the Muddy River Improvement. The 1921 plan also illustrates the development of a rotary at Westland Avenue (see Figure 4-24).

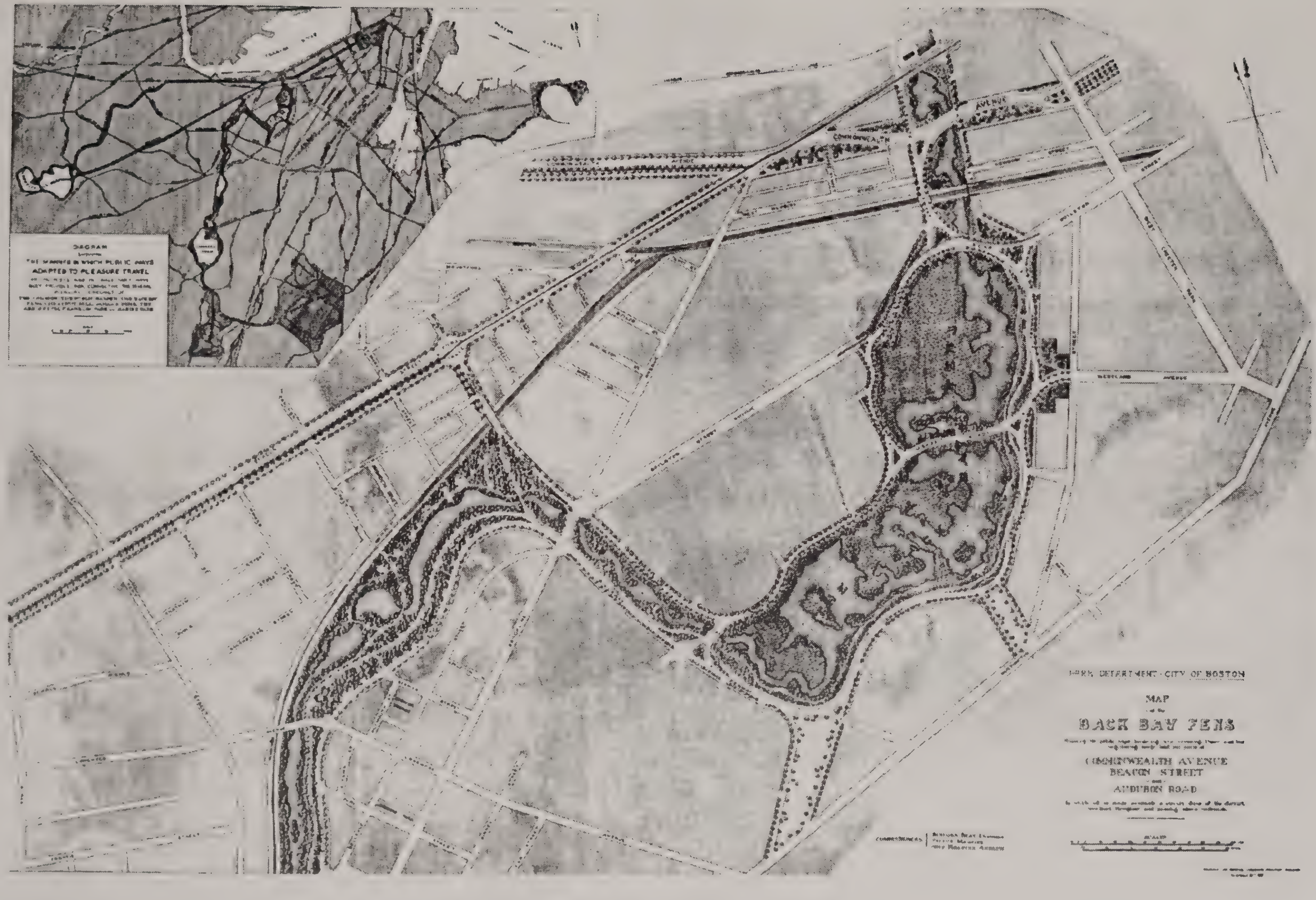


Figure 4-23
Map of the Back Bay Fens, Commonwealth Ave., Beacon St., and Audubon Rd, 1887
Source: FLONHS

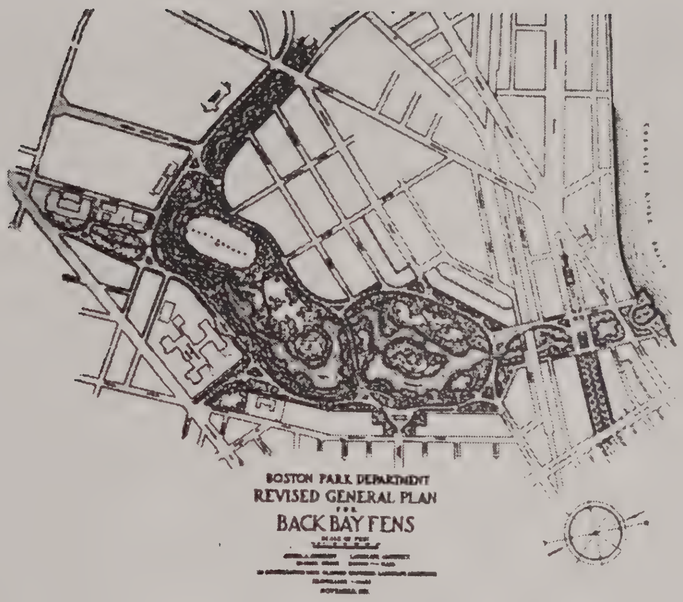


Figure 4-24
Revised General Plan for Back Bay Fens
Arthur A. Shurtleff, Nov. 1921
Source: FLONHS

From 1915 to 1922 a series of studies were conducted by Shurtleff for the Jersey Street Extension. a lagoon reflecting basin opposite the Museum of Arts Evans Wing was constructed in 1914-1915. The lagoon was completed in 1927 and included two nearby wooden footbridges and a third wooden footbridge further to the south at Evansway (see Figure 4-25).

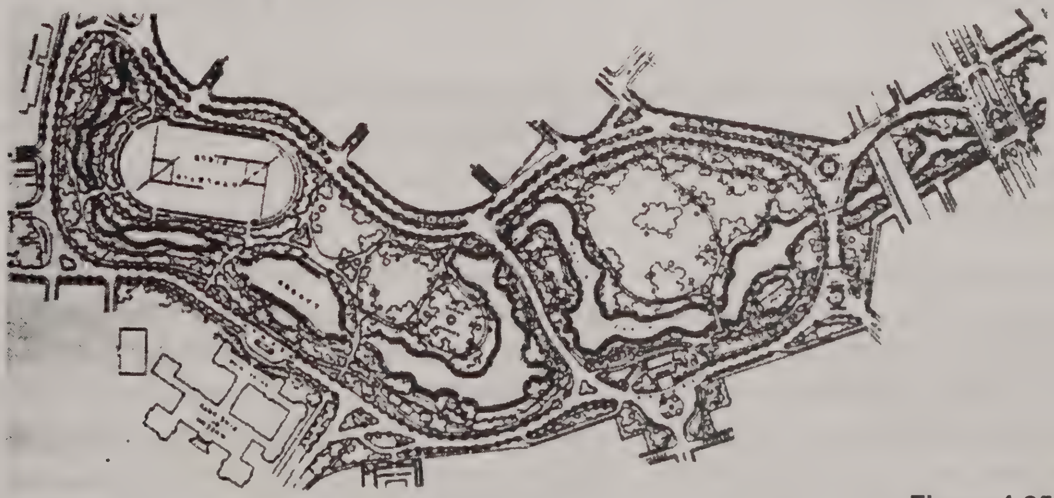


Figure 4-25
Revised General Plan for Back Bay Fens
Arthur A. Shurtleff, 1926
Source: FLONHS

n 1926, Shurtleff completed the Update to the Revised General Plan. The plan was followed by the ntrusion of the Fire Control Center in 1927, the filling in the North Basin in 1927, the Field House and tadium in 1929, modification of the lagoon in 1927 and again in 1930, and the Rose Garden by 1933.

Increased use of the parkways or pleasure drives of the park system as part of the commuter system for an expanding city resulted in the loss of parklands to accommodate wider roads. Audubon Road (Park Drive) and the Fenway Parkway were widened and straightened resulting in the loss of parkland during 1925-1926 (see Figure 4-26).

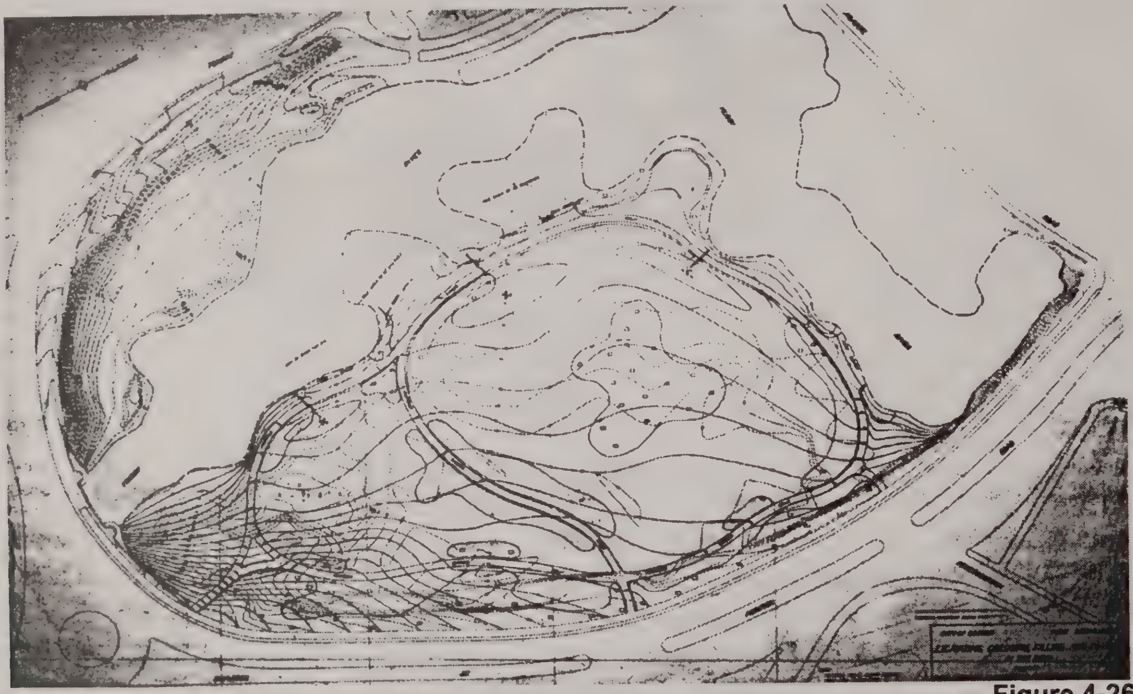


Figure 4-26
Excavating, Dredging, Filling and Loaming in the Fens
Arthur A. Shurtleff, March 24, 1927
Source: BPRD

The Fens no longer had the appearance of a salt marsh; it had lost its distinctive landscape character and had become scenically part of the Muddy River with interspersed elements of ornamental gardening. In significant areas, active sports replaced the quieter and more landscape-oriented uses for which Olmsted had created his design.

Historical plans allow us to determine the line of the shore by the end of the Shurtleff Period, as well as plant massings on the shoreline. We can also overlay the shoreline for the Primary and Secondary Periods of Significance and the existing condition to determine what area of shoreline is extant from each period. An aerial photo documents and confirms the filling what is now the Victory Garden area and the shoreline prior to the invasion of *Phragmities* (see Figure 4-27).

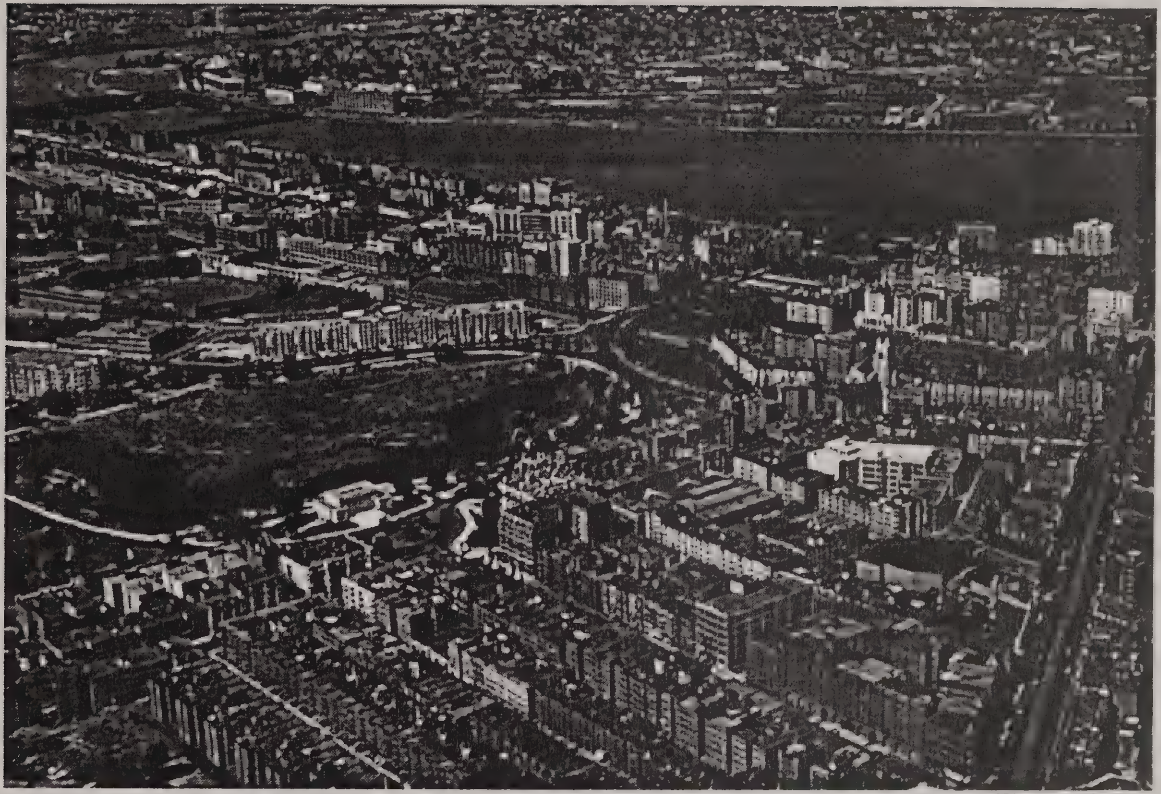


Figure 4-27
Aerial Photo Overlooking the Victory Garden Area
Fairchild Aerial Survey Inc., 1926
Source: BPL Print Room

The Fens continued to change after the Shurtleff Period. The Victory Gardens were introduced into the North Basin fill area in 1940 and the World War II Memorial was added between the Agassiz Road bridge and the Rose Garden. The area in the park set aside for war memorials was placed under the control of the White Fund, which during 1987-1990 restored the Word War II Memorial and additional Memorials for the Korean and Vietnam Wars.

In 1956 the MDC took care and control of the Fenway, Park Drive (Audubon Road), Agassiz Road and Boylston Street as well as a twenty-five (25') foot taking of a right of way into the parkland. Between 1956 and 1982, parkland was taken for road widening, by-passes, turn-arounds and parking, while commuter traffic continually increased, isolating the Fens within a major roadway system. In 1958-1959 the taking of land above the Fens at Brookline Avenue for the Sears Roebuck Company cut into the Fens for a turn-around, demolished the gatehouse and headwalls at Brookline Avenue and filled the Muddy river. Additional filling of the Muddy River occurred at the Fens Bridge and the headwall of the bridge was filled in the process for a new road configuration that never was completed. Historical plans provide information on shoreline location as well as plant massing along the shoreline prior to the filling. The basketball courts were added between the stadium and Rose Garden in the 1970's.

In 1971 The Back Bay Fens was placed on the National Register of Historic Places along with all of Olmsted's Emerald Necklace Parks and on November 1, 1983, the Fens was designated a Landmark by the City of Boston.

Projects completed in the Back Bay Fens since the adoption of the Emerald Necklace Master Plan are documented in the Emerald Necklace Master Plan, herein.

The list of Historic Plans and Plant Lists for the Fens Area is contained in the Appendix C.

4.3.3.2 Land Use

The Back Bay Fens is almost evenly divided between residential and institutional land use with a small commercial area, one of the few commercial zones adjacent to the Emerald Necklace Parks. At the Charlesgate end of the Back Bay Fens, near Boylston St., the land use on both sides of the river is residential with two institutional exceptions. On the Fenway side of the river, the land use becomes entirely institutional beginning just east of Forsyth Street and continuing until Brookline Ave. On the opposite side of the river along Park Drive, the land use remains residential, with the exception of the commercial cluster at Brookline Avenue and Park Drive.

4.3.3.3 Recreation

In The Back Bay Fens, there are both organized and informal sports areas. An athletic field that includes a track and field area and bleacher seating was constructed in 1929. In addition, a baseball diamond is now within the track area. Basketball and volleyball courts, added later, are located in an adjacent area. Less organized active recreation includes paths for activities such as walking, running, and biking and open lawn for informal catch and Frisbee throwing. The Victory Gardens, one of the few gardens established during World War II to still be in active use, provide gardening activity for those who can secure the use of a plot.

There is also passive recreation in the Fens area with numerous benches along the paths, areas of o lawn for informal seating, a rose garden and war memorial area for sitting and viewing. The histor Victory Gardens also provide viewing opportunities.

4.3.3.4 Pedestrian Access

Current pedestrian conditions were examined along key sidewalks and paths throughout The Back Ba Fens portion of the project study area from Boylston Street (Charlesgate area) to Brookline Avenue at the Sears rotary: The Rose Garden, Fenway Park, the reflecting pond, the Victory Gardens, Clemente Field, the Museum of Fine Arts, and the Hynes/Kenmore/Fenway Park MBTA Stations. (Figure 4-28 provides a depiction of this area.)

Pedestrian demands were collected on key sidewalks and paths along Park Drive, the Fenway, Agass Road, and Avenue de Louis Pasteur on a typical weekday in July 2000 from 8:00 AM through 6:00 PM coincident with a scheduled Red Sox home game. The weather at the time of these counts was amenable to pedestrian activity (i.e. warm temperature, no rain). These times were chosen to be consistent with typical periods of activity for a construction project. It should be noted that at the these counts were taken, only a portion of the Landmark Center development at the Sears Rotary constructed and occupied. The majority of the retail space (Bed Bath & Beyond and Staples) and the cinema had opened prior to these counts. Table 4-10 provides a summary of the demands that were observed. These are also depicted graphically on Figure 4-28.

Table 4-10
Pedestrian Volume Summary – The Back Bay Fens Area

Sidewalk	Morning Peak Volume (peds per hour)	Evening Peak Volume (peds per hour)
Rose Garden Path - diagonal path connecting Park Drive and the footbridge at the Museum of Fine Arts	115	75
Agassiz Road	50	60
Avenue de Louis Pasteur – Crossing the Fenway	165	130
Park Drive – near Clemente Field	90	150
Louis Pasteur Path – internal paths Connecting the Fenway and Park Drive near Avenue de Louis Pasteur	40	40

Source: Pedestrian counts conducted by VHB in July 2000.

n general, the bulk of the pedestrian activity in this area originated near Clemente Field, the Rose Garden, and across the Fenway at Avenue de Louis Pasteur. In the morning, the peak demand in this area was approximately 165 pedestrians per hour. Peak demand occurred at about 8:00 AM at the rosswalk across the Fenway at Avenue Louis Pasteur. In the evening, the peak pedestrian demands in his area were 150 pedestrians along the sidewalk adjacent to Clemente Field. Pedestrian demands in he vicinity of the Rose Garden were 115 pedestrians per hour in the morning and 75 pedestrians per our in the evening. Observed demands crossing Agassiz Road were 50 pedestrians per hour in the morning and 60 pedestrians per hour in the evening. Demands on the internal paths between Park Drive and the Fenway at Avenue Louis Pasteur were, at most, 40 pedestrians per hour. At the Sears otary, the majority of the pedestrian activity is focused near the Fenway MBTA Station.

here were no observed locations in The Back Bay Fens area where sidewalks are discontinuous or where pedestrian safety is compromised. There are sidewalks on both sides of Agassiz Road and wide houlders are provided between the sidewalks and the travelway. All sidewalks are concrete and are n good condition. There are a few informal, unpaved paths in this area that are used mostly by ggers. Cobblestone crosswalks are provided across Park Drive and the Fenway at various locations.

edestrian demands are influenced by public transit in this area. This area is well served by several earby subway stations. There are several nearby Green Line stations on the D- Line and E- line. hese are: Hynes Convention Center; Kenmore; Fenway Park; Symphony Station ;the Northeastern niversity Station; and Museum of Fine Arts Station. The MBTA bus routes 8, 47, 60, 65, CT-2 and CT- provide service to this area. These bus routes service the area through existing stops along Brookline venue, Boylston Street, and at the Park Drive overpass to the Fenway station.

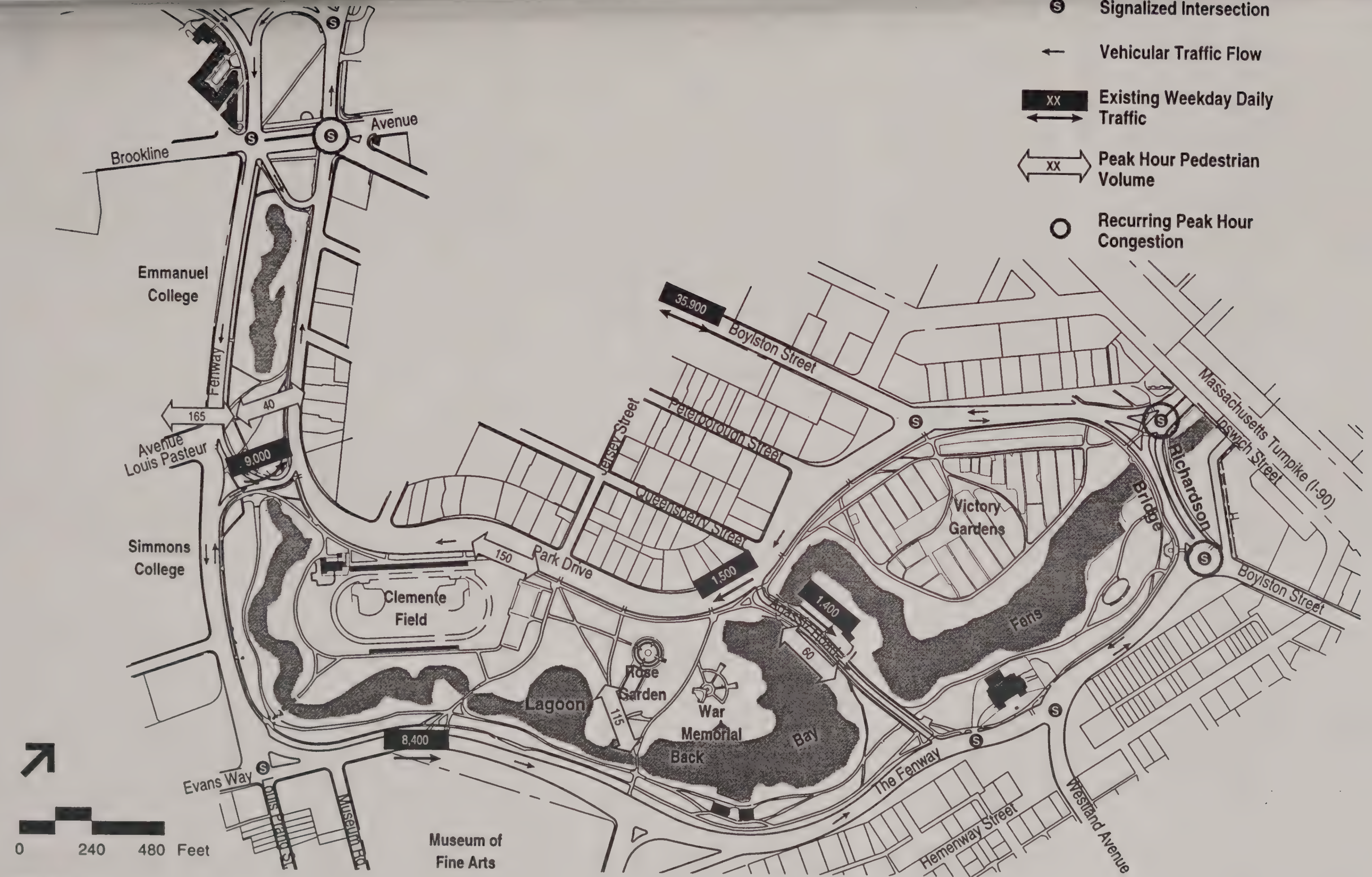


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Figure 4-28
Muddy River Restoration
Back Bay Fens Area Existing Traffic Conditions

Source: VHB, Inc.

Counts of bicyclists in the area were conducted concurrently with the pedestrian counts. All of the roadways in the Back Bay Fens Area allow for bicycle travel although there are no designated bicycle paths or bike lanes. Bicycle counts conducted north of the Sears Rotary on Brookline Avenue indicate that approximately 15 to 25 bicyclists cross Brookline Avenue during an average weekday morning peak hour, mid-day peak hour or evening peak hour. The existing crosswalk widths and signal timing provisions appear to be adequate to process the existing bicycle volumes.

4.3.4 Traffic

Traffic conditions in The Back Bay Fens area of the Olmsted Emerald Necklace Park system from Boylston Street (the Charlesgate area) to Brookline Avenue at the Sears rotary, were examined, as indicated on Figure 4-23. The bulk of the traffic demands through this area are carried by a few key roadways, predominantly due to the one-way circulation patterns and to the fact that portions of the Fenway and Park Drive are restricted to passenger vehicles only. Agassiz Road is a U-turn between Park Drive and the Fenway. The other U-turn in this area directs traffic from the Fenway onto Park Drive at Avenue de Louis Pasteur.

Park Drive, the Fenway, The Riverway, Boylston Street and Brookline Avenue merge to form the Sears Rotary. Brookline Avenue runs from Kenmore Square to the north in a general southwesterly direction to the Rotary and continues to the west where it becomes a key arterial servicing the Longwood Medical Area. Boylston Street runs in a general east-west direction and terminates at the eastern edge of the Rotary where it merges with Brookline Avenue. The Fenway and The Riverway serve as a one-way couple adjacent to the Back Bay Fens. Park Drive runs in a general north-south direction. North of the Rotary, Park Drive becomes bi-directional. The Riverway generally parallels the Muddy River. The Riverway runs between Brookline Avenue and terminates with its intersection with the Fenway. West of the Fenway, The Riverway is bi-directional it becomes one-way in the southerly direction, south of Park Drive. These roadways are key commuter routes that form important links between the Longwood Medical Area, Back Bay, and downtown Boston.

To provide a relative comparison of traffic demands on key roadways through this area of the Back Bay Fens, existing traffic demands were collected along Boylston Street, the Fenway, Park Drive, Agassiz Road, and the U-turn at Avenue de Louis Pasteur in July 2000. It should be noted that at the time these counts were taken, only a portion of the Landmark Center development at the Sears Rotary was constructed and occupied. The majority of the retail space (Bed Bath & Beyond and Staples) and the cinema had recently opened prior to these counts. Table 4-10 provides a summary of the existing traffic demands that were collected. Figure 4-28 summarizes these volumes graphically. The volumes on this and the remaining Traffic Summary tables in Section4 have been compared with data from Fenway Mixed Use Project Draft Impact Report (DPIR), MASCO LMA 1999 Transportation Study Update, and the Emmanuel College PIE/ EIR and the difference were found not the be significant.

Table 4-11
Traffic Volume Summary - The Back Bay Fens Area

Roadway	Morning Peak Hour Volume (vph) [1]	Evening Peak Hour Volume (vph)	Weekday Daily Volume (vpd) [2]
Boylston Street – west of Kilmanock Street	2,310	2,320	35,900
The Fenway/Park Drive U-turn at Avenue de Louis Pasteur	710	725	9,000
The Fenway - south of Forsyth Way	470	710	8,400
Park Drive – north of Jersey Street	100	180	1,500
Agassiz Road – near Park Drive	65	165	1,400

Source: Traffic counts conducted by VHB in July 2000.
Peak hour volume, expressed in vehicles per hour (vph).
Daily volume, expressed in vehicles per day (vpd).

Boylston Street is a heavily traveled, four-lane urban arterial roadway that carries 35,900 vpd. Land uses along Boylston Street primarily are commercial. There is on-street metered parking provided on both sides of the roadway. Within the study area, Boylston Street is owned and maintained by the City of Boston. The Fenway and Park Drive are MDC roadways carrying much less traffic than Boylston Street, 8,400 vpd and 1,500 vpd, respectively. Boylston Street and Park Drive/the Fenway carry simila origin-destination pairs. Traffic between the Sears rotary to the I-90 overpass and Back Bay can use either of these routes. The Agassiz Road U-turn, another MDC roadway, carries about 1,400 vehicles daily. The U-turn at Avenue de Louis Pasteur is estimated to carry approximately 9,000 vpd.

The volume of traffic along Boylston Street raises capacity issues and operational deficiencies. The existing capacity along Boylston Street was evaluated using traffic counts along the corridor. The following capacity deficiencies have been identified:

- ***Boylston Street/Park Drive at Brookline Avenue*** - This signalized intersection operates over capacit (LOS F operations) in the morning and evening peak periods. High demands on all approaches entering the intersection result in long delays and queues.
- ***The Boylston Street corridor*** - Between Brookline Avenue and Park Drive, the Boylston Street corridor is over capacity. This 4-lane section of Boylston Street handles a significant volume of traffic. In addition, there are on-street parking maneuvers and double parking activities that

effectively reduce the capacity of this roadway link. There are intersection deficiencies along the Boylston Street corridor at Yawkey Way/Jersey Street and Kilmarnock Street. These deficiencies are exacerbated just prior to and after Red Sox home games. There is also a surge in traffic demands during the move in period for the area colleges.

In addition to capacity deficiencies along Boylston Street through the Fenway area, the two signalized intersections where Boylston Street intersects Park Drive, the Bowker Interchanges, and the Fenway experience recurring peak hour congestion. There is also a geometric issue at the traffic signal at the intersection of Boylston Street and Park Drive near Bowker Interchange. From the Bowker Interchange southbound, traffic merges right onto Boylston Street in two lanes along a two-way segment of Boylston Street. To go northbound on Boylston Street, motorists must turn left at this traffic signal. Although there is no left-turn lane designation, the traffic signal has a protected left-turn phase. This geometric issue does not result in notable traffic congestion.

4.4 The Riverway

4.4.1 Physical Environmental Features

The Muddy River flows north from Leverett Pond and into that portion of the Emerald Necklace referred to as the Riverway (see Figure 4-29). The Riverway is located in both Boston and Brookline. It is bordered on both sides with linear grassed parkland, and numerous, paralleling and intersecting roadways. On the Boston side, the Muddy River is paralleled by the MDC-maintained Riverway roadway. On the Brookline side the MBTA's Green Line tracks run parallel to the Muddy River through approximately one half of the length of the Riverway park until local roads begin to border the park. With the exception of a rip-rapped channel immediately downstream of the Route 9 bridge and the area under Longwood Avenue Bridge, the shoreline of the Muddy River along both sides of the Riverway consists of natural terrain.

The Riverway contains three islands along its length, all planned in the Olmsted design. The only accessible island is located between Brookline Avenue and Netherlands Road, where formal stairs and bridges provide pedestrian access to the maintained island park. The other two islands are not maintained and are not easily accessible.

The Riverway contains a number of stormwater outfalls. Most noteworthy among them are the Huntington Avenue Drain, Tannery Brook Drain, and the Longwood Avenue Drain, all of which are located in Brookline.

4.4.1.1 Hydrology

The Riverway section of the Muddy River extends from The Riverway (road) and Brookline Avenue area at the downstream end (~RM 1.70) up to Route 9 (~RM 2.80). Significant flooding occurred during the October 1996 storm in this reach of the river.

During this storm, the water levels in the Muddy River upstream of Brookline Avenue were the highest since the hurricane-related flooding of August 1955 and the Muddy River nearly overtopped the flood control dike in the Riverway. Because of high waters in the river, floodwaters from local drainage systems tributary to the Muddy could not discharge, and they flooded local neighborhoods. The

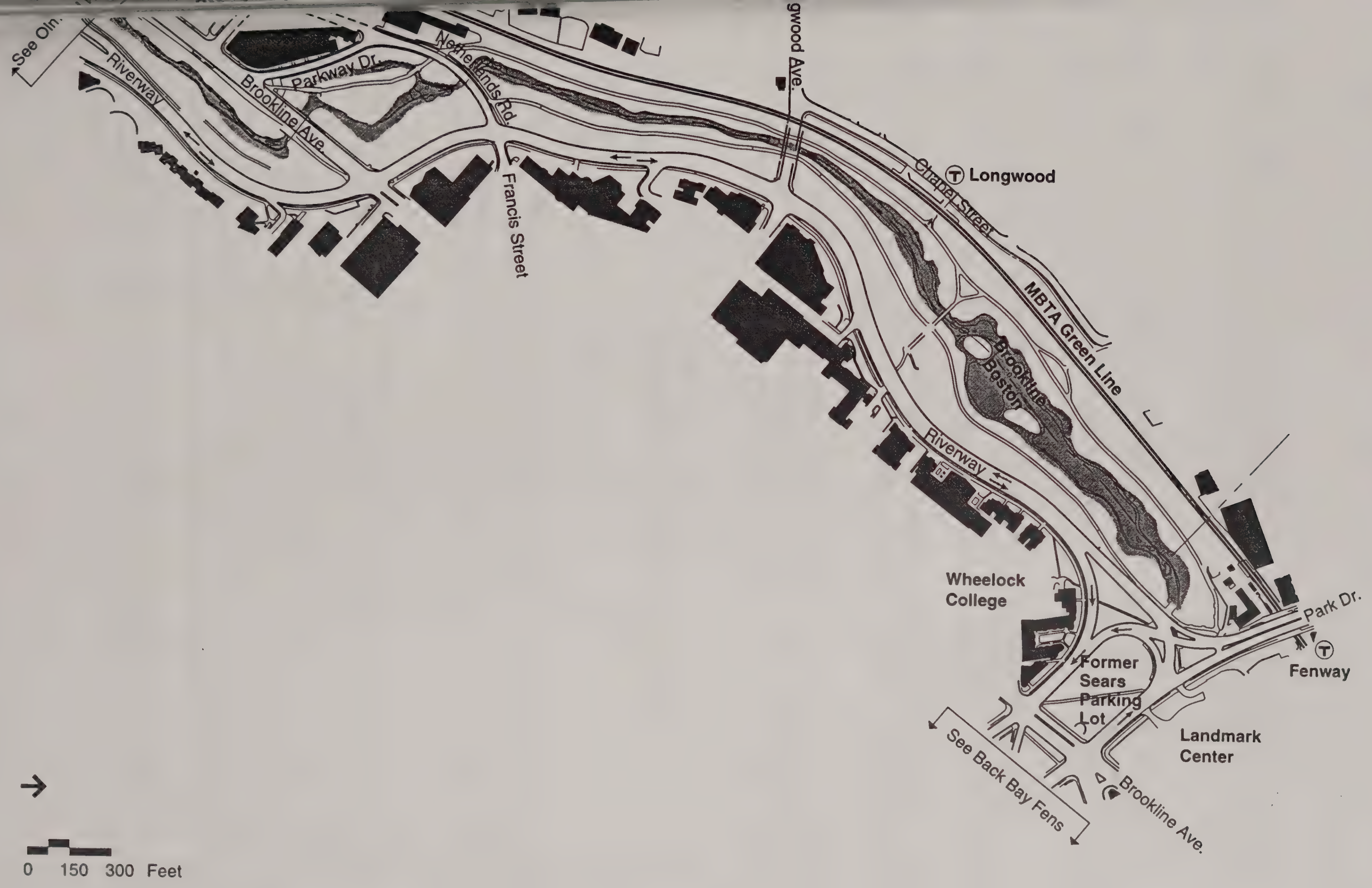

Figure 4-29
The Riverway
Source: VHB, Inc.

floodwaters flowed along the MBTA Green Line tracks along the western side of the river, and inundated the Kenmore MBTA Station. About 30 million gallons of water reportedly entered the station, resulting in significant damage, closure of the station, and disruption of service for several months.

The river widths in The Riverway range anywhere from about 30 to 150 feet. The side slopes are generally shallow ranging from 1:10 to 1:20 ft (y:x). The bed elevation in the upstream end of The Riverway, near Route 9, is about 3.3 ft BCB, but then varies around 4.0 ft throughout the rest of The Riverway down to the culverts at Riverway Road and Brookline Avenue.

Flows in The Riverway during dry weather conditions generally are around 2 to 3 cfs. The corresponding dry-weather elevation in the Riverway is about 8.0 ft BCB, the same elevation extending up from the Charles River and similar to the other downstream reaches.

The hydraulic analysis of the entire Muddy River indicates the cause of flooding in The Riverway was due to constrictions downstream of the Riverway area, primarily in the reach of culverts underneath the Riverway (road) and Brookline Avenue.

The flows in the downstream end of the Riverway during the October 1996 storm were about 520 cfs. The major drains contributing to the Riverway are the Longwood Avenue, Tannery Brook, and Huntington Avenue drains. Each of the drains had the following contribution during the October 1996 storm:

Drain	Drainage Area (Mi^2)	Peak Flow (cfs)	Volume (MG)
Longwood Avenue	0.29	108	31.2
Tannery Brook	0.53	148	44.7
Huntington Avenue	0.08	28	9.6

The profile of the maximum water elevations reached during the storm in the Riverway area of the Muddy River is shown in Figure 4-30 using the modeled tailwater elevation at the Charles River of 8.5 ft.. The downstream end, where the river enters twin 6-ft culverts at the Riverway road (~RM 1.70), shows a peak elevation of 18.87 ft BCB. The upstream end of the reach, at Route 9, is shown to be about 18.93 ft BCB.

The modeling profile indicates that even during the October 1996 storm, little head loss was observed in the Riverway itself. In fact, model simulations indicate a similar trend of a flat hydraulic gradeline in the Riverway for all storms modeled, ranging from a 2-year storm up to a 100-year storm (see Appendix E). The flat HGL indicates that the Riverway itself has ample capacity to convey the flow observed in all design storms, including the October 1996 storm. The rise in water elevation observed in the Riverway is primarily caused by the constrictions that exist downstream, mainly under Brookline Avenue. If these constrictions were removed or reduced by improving the capacity of the Muddy in the downstream areas, then the water level in the Riverway could be reduced greatly during storms.

As shown in Figure 4-31, the existing water flow velocity through the Riverway portion of the Muddy River ranges from less than 0.3 feet per second (fps) at the twin culverts at the Back Bay Yard to over 4 fps at Netherlands Road.

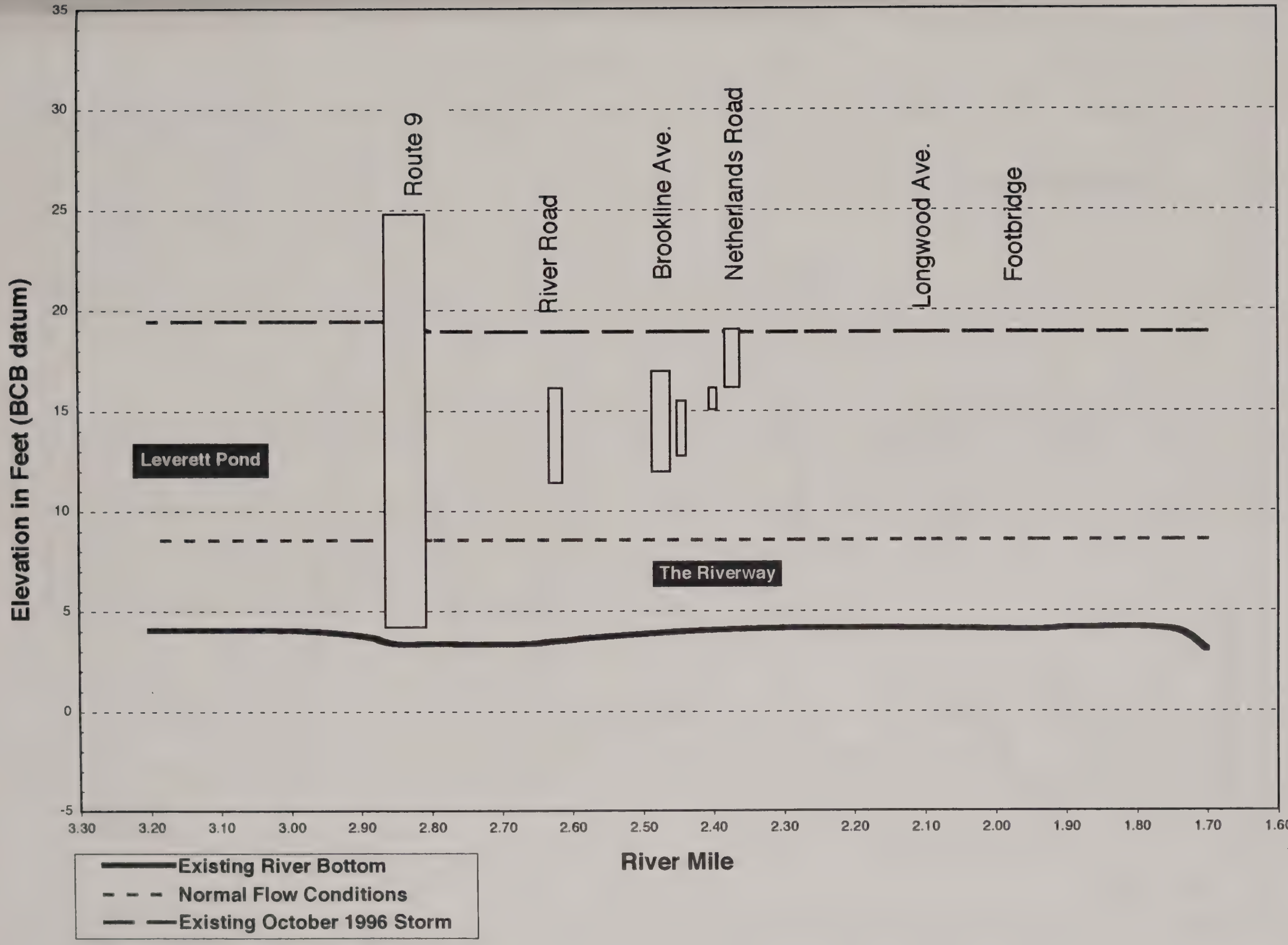

Figure 4-30
Peak Hydraulic Grade Line–October 1996 Storm
Existing Conditions–Riverway

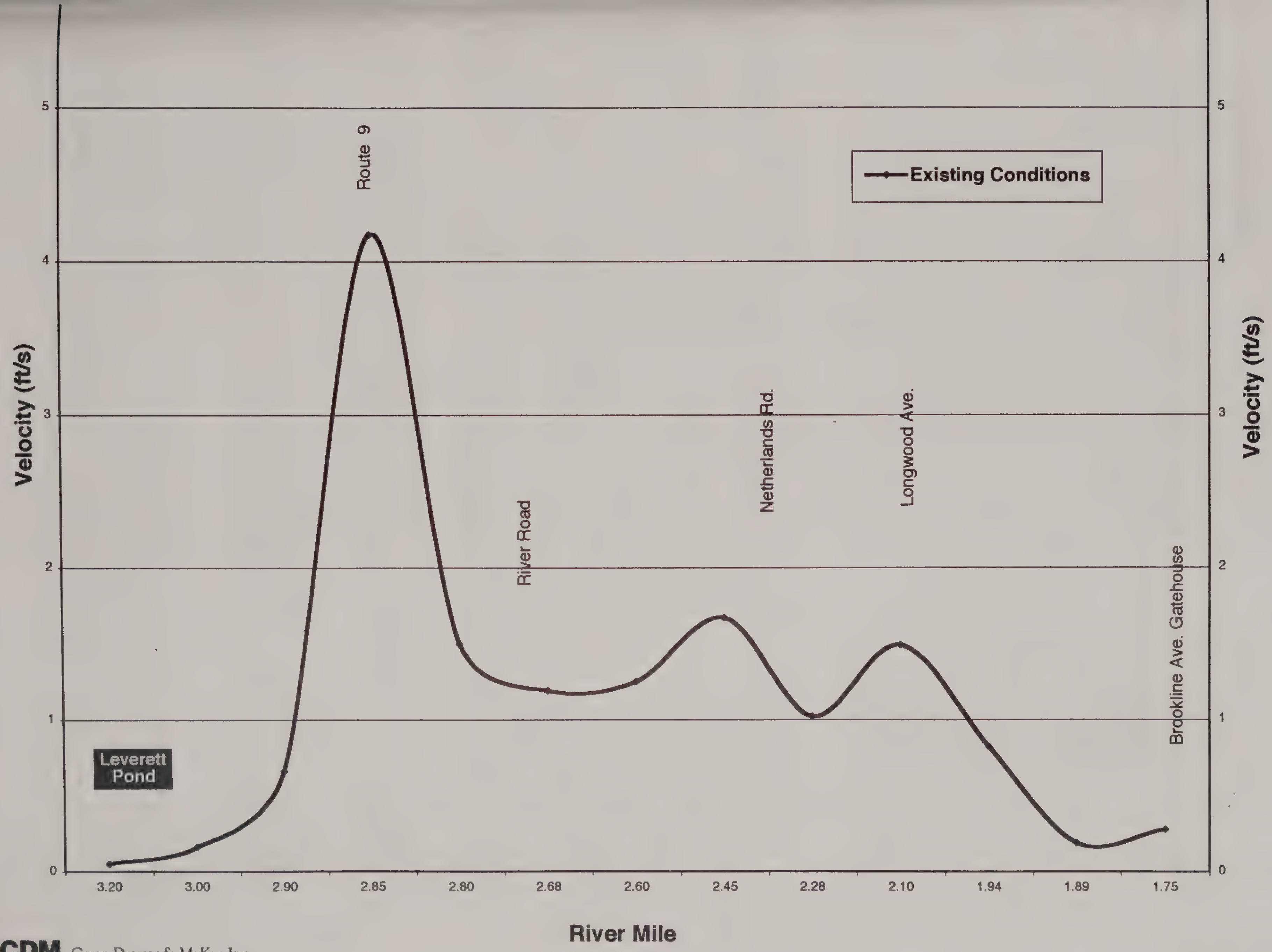

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Figure 4-31
Simulated Velocities in the Riverway Section of the Muddy River
October 1996 Storm

4.4.1.2 Sediment Quality

The Riverway borings were completed(summer 2000) to a maximum depth of sixteen feet below the top of sediment or until native material was encountered. The general stratigraphy encountered during the advancement of the borings consisted of varying thickness (2 to 10 ft) of a soft, black, organic silt layer, intermixed with fine to coarse sand and gravel. Organic material was typically observed in the upper limits (0 to 2 ft) of sediment. However, this material was observed to depths of eight feet at the southern limits of the Riverway area. The native material underlying the silt layer typically was observed at two to ten feet below the top of the sediment. Native material consists of black-grey, medium dense to very dense, fine to medium sand with varying amounts of fine gravel, and silt. Small amounts of silty clay and peat were observed within the native material at the northern limits of the Riverway Area. Petroleum odors were noted in samples collected from a few boring locations within the Riverway Area, specifically at boring locations RW-SED-1, -4 and -9. These samples were collected in areas of miscellaneous fill or organic material. Samples were not recovered from three proposed locations due to low recovery volumes of sediment material that consisted of mostly gravel. The locations were downstream of the section where the Riverway crosses Brookline Avenue.

The analytical results of the VPH scan show similar concentrations of the C_9 to C_{10} aromatic hydrocarbons in samples collected from the southernmost section of the Riverway (i.e., sample locations RW-SED-01 through RW-SED-09). Concentrations in the 0 to 2 ft depth interval ranged from 14 mg/kg to 42 mg/kg with most of the samples at a concentration of 23 mg/kg. The target compounds toluene, xylenes and naphthalene were also consistently detected in these samples. Naphthalene was the only compound detected at a concentration above 1 mg/kg. The results of samples collected further downstream primarily showed low levels of naphthalene. These results are consistent with the results of the EPH scan as several locations had EPH and target PAH concentrations above the DEP landfill reuse levels. Samples of fill material at locations RW-SED-04, RW-SED-09, RW-SED-19, RW-SED-21, RW-SED-27, and RW-SED-33 through RW-SED-37 contained EPH at concentrations above 2,500 mg/kg. Samples collected from nine locations contained total PAH compounds above 100 mg/kg. The highest results were collected from location RW-SED-19 at the 0 to 2 ft and the 2 to 4 ft depth intervals at concentrations of 372 mg/kg and 399 mg/kg, respectively.

No detectable levels of PCBs were found in samples collected from the Riverway. For the pesticide scan, 4,4'-DDD was the only compound detected except for one sample that showed 4,4'-DDT. The concentrations of 4,4'-DDD ranged from below detectable levels to 4.4 mg/kg in a sample of fill material collected at location RW-SED-35.

Select samples also were analyzed for nitrates and total phosphorus. Nitrates were not detected. Results of the total phosphorus concentrations show elevated levels in most of the samples. The concentrations of total phosphorus ranges from 262 mg/kg to 3,180 mg/kg. The concentrations generally increased with depth.

Several samples had concentrations of arsenic above the DEP landfill reuse level of 40 mg/kg. These locations include RW-SED-01 (45 mg/kg), RW-SED-03 (89 mg/kg), RW-SED-26 (40 mg/kg), RW-SED-28 (47 mg/kg at the 0 to 2 ft interval and 50 mg/kg at the 2 to 4 ft interval), and RW-SED-34 (65 mg/kg). Only seven samples had concentrations of lead at or above 1,000 mg/kg. None of the samples analyzed exceeded the regulatory limit for TCLP lead. Reactive cyanide and sulfide were not detected above their respective federal regulatory limits. Three samples were tested for the paint filter test. The results showed that there was no free liquid present in the samples. The analytical results for the Riverway are summarized in Table 4-12. The methodology for the sediment test program, analytical results, and summary figures are included in Appendix F.

Table 4-12
Summary of Sediment Analytical Results - Riverway

Contaminant	No. of Samples	Concentration [1] Minimum	Concentration [1] Maximum	DEP Landfill Reuse Levels [1] Unlined	DEP Landfill Reuse Levels [1] Lined	No. of Samples Exceed Unlined	No. of Samples Exceed Line
Total Arsenic	82	ND	89	40	40	6	6
Total Cadmium	82	ND	17	30	80	No Exceedances	
Total Chromium	82	ND	190	1000	1000	No Exceedances	
Total Lead	82	ND	2000	1000	2000	7	1
TCLP Lead (mg/L)	48	ND	3.3	NA	NA	No Exceedances	
Total Mercury	82	ND	3.3	10	10	No Exceedances	
Total EPH	82	ND	7700	2500	5000	15	3
Total PCBs	46	Not Detected		<2	<2	No Exceedances	
Total PAHs	82	ND	399	100	100	13	13
Total VPH	82	ND	46	NA	NA	No Exceedances	
Total VPH Target	82	ND	2.4	4	10	No Exceedances	
Reactive Sulfide	47	Not Detected		500		No Exceedances	
Reactive Cyanide	47	ND	7	250		No Exceedances	
pH	38	5.5	8.4	2 < pH < 12.5		No Exceedances	
Conductivity	44	7	270	4000 umhos/cm	8000 umhos/cm	No Exceedances	

[1] All results are reported in mg/kg unless otherwise noted.

Elutriate analyses were conducted on sediment from the Riverway in order to determine, if during the process of hydraulic dredging, if any toxic metals could be released to the environment. The metals that were analyzed included those that are required by the ACOE and the MA DEP, i.e. antimony, arsenic, beryllium, cadmium chromium, copper, lead, mercury, nickel, selenium, silver, thallium, zinc. In the elutriate analysis procedure, sediment is mixed with water at the same general ratio as would occur during hydraulic dredging, i.e. 1 part of sediment to 5 parts of water. The sediment and water are mixed, filtered, and tested. The receiving water is also tested for the same constituents. The difference in concentrations indicate the magnitude of the toxins that could be released during the dredging. The sample location(s) that were selected were done so because the results of the bulk sediment characterization indicated high levels of contamination. An elutriate analysis was conducted on sediment that was collected from the Riverway opposite the Carlton Street Bridge (sediment sample RW Sed 35, and at a location that is opposite the Longwood MBTA Station (sediment sample RW Sed 28). These sediment sample locations are shown on Figure F2-3A in Appendix F. The tests on sediment sample RW Sed 35 resulted in the release of 0. 0.013 mg/l of arsenic. The concentration of arsenic that was released is below the acute and chronic freshwater water quality criteria of 0.360 mg/l and 0.190 mg/l, respectively. The tests from sediment sample RW 28 did not result in a release of toxic metals.

4.4.1.3 Water Quality

Water flows north from Leverett Pond and through a large arch culvert under the Route 9 bridge. The first of the large stormwater outfalls, the Huntington Avenue Drain with a drainage area of 70 acres, discharges into the Muddy River within a short distance (see Figure 4-32). Further downstream is the discharge from Tannery Brook (354 acre drainage area). The outfall for the Longwood Avenue Drain discharges to the Muddy River a short distance downstream of the Netherlands Road bridge.

The Massachusetts Department of Environmental Protection (DEP) has established Water Quality Standards for all waters in the Commonwealth. The Muddy River watershed has been classified as Class B waters, which are considered swimmable and fishable.

In order to assess the water quality of The Riverway, a review of the water quality history was conducted and water was sampled and tested as part of this project. Historical water quality data includes that from the:

Division of Water Pollution Control (now the MA DEP)	1974
Division of Water Pollution Control (now the MA DEP)	1986
Army Corps of Engineers	1992
Northeastern University	1995
Charles River Watershed Association (CRWA)	1998

In addition, at Netherlands Road, the US Geological Survey has operated a station for flow and water quality monitoring (MA01104683) since 1999.

The historical data indicated that bacteriological water quality standard of <200 bacteria per100 ml of water, and/or the dissolved oxygen water quality standards (>5 mg/1 and 75% of saturation) were not met in 1974, 1986, 1992, and 1998 (temperature, dissolved oxygen and pH were not tested by the CRWA). While testing diurnal oxygen dynamics in the Muddy River, Northeastern University scientists discovered that the dissolved oxygen was below the Class B water quality criteria. The water quality of the Riverway did meet the temperature (<20°c) and pH (6.5-8.3) standards during these years as well.

Vhile the Water Quality Standards do not have numeric criteria for suspended solids, nitrogen and hosphorus, certain limnological (the study of freshwater ecology) water quality guidelines (Sawyer) vere applied to the Muddy River because of its lotic (slow moving) character. These were 20 nilligrams per liter (mg/l) for total suspended solids (TSS), 0.30 mg/l for inorganic nitrogen (the ummation of nitrate, nitrite, and ammonia nitrogen forms), and 0.01 mg/l for total phosphorus. pplying these values against the historical data, it was noted that excessive nutrient conditions in The iverway occurred during 1992, 1995, and 1998.

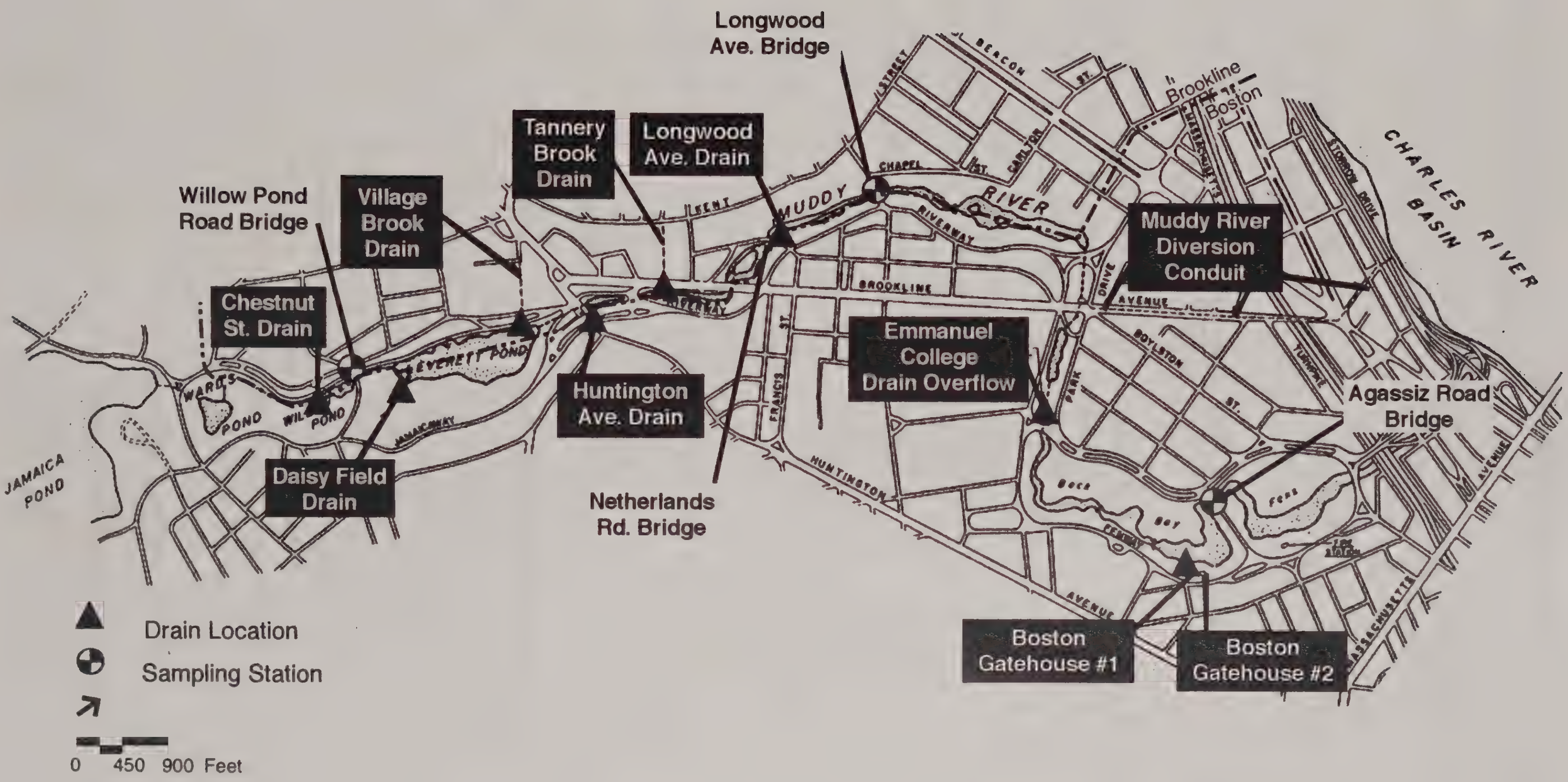


Figure 4-32
Muddy River Sampling Stations
Source: BPRD

During the autumn of 2000, the water quality of the Riverway and its large discharges (see Figure 4-26) were analyzed for the following parameters:

Temperature	Nitrate plus Nitrite Nitrogen
Dissolved Oxygen (DO)	Ammonia Nitrogen
pH	Total Phosphorus
Turbidity	Fecal Coliform Bacteria
Total Suspended Solids (TSS)	Fecal Streptococcus Bacteria
True and Apparent Color	

The testing results indicated the following water quality conditions during dry (October 4) and wet (October 16 and December 14, 2000) conditions:

Water Quality Parameter	**Longwood Avenue Drain**	**Muddy River at Longwood Ave. Bridge**	**Tannery Brook Drain**	**Huntington Avenue Drain**
TemperatureP/P/	P/P/P	P/P/P	P/P/P	P/P/P
Dissolved Oxygen (DO)	F/P/P	F/P/P	P/P/P	P/P/P
pH	P/P/P	P/P/P	P/P/P	P/P/P
otal Suspended Solids (TSS)	P/P/F	P/P/F	F/P/F	P/F/F
norganic Nitrogen	F/F/F	F/F/F	F/F/F	F/F/F
otal Phosphorus	F/F/F	F/F/F	F/F/F	F/F/F
ecal Coliform Bacteria	P/F/F	P/P/F	F/F/F	P/F/F

- Pass
- Fail
/F/F - Pass dry weather/Fail wet weather/Fail wet weather
December 14, 2000)

he water quality report is contained in Appendix G.

1995 the Town of Brookline entered into a Consent Agreement with the US Environmental rotection Agency to investigate and remove illegal sewerage connections to the Muddy River rainage system. As a result of these investigations, 39 sources of sewage equivalent to 185 dwelling urces were located and subsequently removed. Separation of sewers in Brookline in the area of High nd Walnut streets, which are tributary to Chestnut Street Drain, will be completed in Spring of 2001. dditional work will be undertaken in the lower Beacon Street, St. Mary's Street, and Carlton Street. rookline is also focusing on correcting infiltration to its sanitary sewers. There has been some inter-unicipal connections from Boston to Brookline where the sewers were not separated and the mbined flows discharged to the drainage system. Boston has corrected many of these problems and e sewer system at Cleveland Circle that discharged to the Village Brook Drain and those in the area of rtlett Crescent that discharge into Tannery Brook Drain are the locations of ongoing work.. This aves only stormwater as the main water source in the drainage system.

e dissolved oxygen concentrations were high during dry and wet weather and were present at 115 rcent of saturation during dry weather and 85 percent during wet weather. The dissolved oxygen ncentrations were determined in the field by using calibrated dissolved oxygen meters. The high percent saturation level was verified through Winkler titration. As shown by the alkalinity value, the water in the Village Brook Drain adds buffering capacity against downward changes in pH with alkalinity values averaging 35 mg/l. The water in the drainage system was found to contain a somewhat alkaline pH (7.8 units). The turbidity and total suspended solids levels were low. There was no indication of humic materials in the water as the true and apparent color values were essentially the same. The inorganic nitrogen and phosphorus concentrations during dry weather were slightly higher than would be desired. These values increased several-fold during wet weather conditions. In keeping with EPA guidance, the Massachusetts Department of Environmental Protection is developing guidelines for nutrient limitations where the technology based point and non-point source pollution controls are not stringent enough to meet the water quality standards. These guidelines are planned to be issued in 2003.

4.4.2 Biological Environment

The environment surrounding The Riverway consists of a maintained urban park with mature trees, grass and some shrubs. *Phragmites* and Japanese knotweed are dominant in a number of locations and the habitat diversity along the Riverway is not as desirable as it is in Olmsted Park. The following sections include information on the existing woodlands, horticultural resources and aquatic and wildlife resources and wetlands along the Riverway section of the Muddy River.

4.4.2.1 Upland Vegetation and Horticultural Resources

The inventory, documentation and analysis of vegetation in The Riverway Area were completed in August of 2000. The area includes the watercourse from The Riverway parkway at Sears Park to Route 9 (Tremont Street). The scope of work included trees, shrubs, vines, and lawn areas including notation of areas of bare lawn and erosion.

Vegetation breakdown under trees includes:
Deciduous trees - indicating species, caliper and condition
Evergreen trees - indicating species, caliper and condition
Woodland

Vegetation breakdown under shrubs includes:
Restored planting with five years of restoration
Shrub massings
Invasive plant colony - indicating species

Erosion includes:
Bare lawn
Wash outs of storm sewers
Desire lines
Overuse Compaction
Surface roots trees

Analysis of Existing Vegetation is contained in Table 4-13

Table 4-13
Inventory and Analysis of Existing Vegetation - Riverway

Category	Unit	Total	Good	Fair	Poor	Dead
Trees:						
Canopy tree	each	701	54	579	66	2
Flowering tree	each	81	5	71	5	0
Evergreen tree	each	0	0	0	0	0
Heritage tree[1]	each	129	40	70	19	0
Total Trees:		**911**	**99**	**720**	**90**	**2**
Shrubs:	(Estimated)					
Restored planting	square footage	10,824				
Shrub massing	square footage	9,835				
Total Shrubs:		**20,659**				
Invasive Plant Colonies:	(Estimated)					
Phragmites	square footage	108,595				
Other Invasives (e.g. Knotweed	square footage	160,113				
Total Invasive Plant Colonies:		**268,708**				
Woodland:	(Estimated)					
	square footage	**273,868**				

[1] Note: A heritage tree is a canopy tree with a 32" or greater caliper. If it is listed as a heritage tree, it will not be listed as a canopy tree.

In accordance with the Commonwealth of Massachusetts Department of Environmental Management standards, trees that are 32 inches in caliper and over are considered to be heritage trees. All trees have their species and caliper size identified and the condition of the heritage trees is rated as good, fair or poor as are all other trees on the site. The diameter of the circle for tree canopy is in relation to its caliper size.

Plan documentation is contained in the Appendices in the form of annotated Existing Conditions Plans.

4.4.2.2 Aquatic and Wildlife Resources

Under normal flow conditions, the Riverway is a slow moving stream ranging in width from less than 20 feet to more than 100 feet. Due to the developed, impervious nature of the watershed, the volume of base flow is very low, resulting in almost stagnant conditions during prolonged dry periods. The mean annual flow is calculated to be 8 cubic feet per second (cfs) and the seven day-10 year low flow volume is <0.05 cfs.

Although shade trees are prevalent, the water is warm, carrying over from Leverett Pond. The wider parts of the Muddy River in the Riverway section are not shaded and the water is very shallow which promotes additional heating. The water in the Riverway is turbid as a result of algae growth and suspended soft sediments. Existing biological resources data were reviewed from the ACOE (US Army Corps of Engineers, Appendix D, July 1996) and information that was generated during the Wildlife

Habitat Evaluation and Vegetation Assessment of the Riverway that was conducted during this project (see Appendix D).

Benthic Aquatic Resources
Aquatic benthic resources consist of those organisms, which, through part or all of their life cycles, inhabit the bottom of the resource area. Because of their long-term contact with the bottom sediments and water, the benthic community typically reflects the chemical quality of the sediments and water. The benthic organisms range from those that are pollution intolerant and inhabit only the cleanest of bottom deposits, to pollution tolerant species which inhabit contaminated sediments. Depending on water and sediment quality, the benthic community in ponds may consist of various species of fly larvae (e.g. true flies, caddisflies, may flies, stoneflies, dragonflies, etc.), worms, leeches, various species of crustaceans, snails and other species. The benthic community serves as a food source for such bottom feeding fish as the carp, suckers and goldfish, as well as smaller forage fish species. Ducks and geese also feed upon these organisms.

The surface sediment in the Riverway (see Section 4.4.1.2 – Sediment Quality) was found to contain high concentrations of petroleum hydrocarbons, polynuclear aromatic hydrocarbons and heavy metals. One sample was found to contain the insecticide dichlorodiphenyltrichloroethane, p,p' (DDT).

The ACOE's benthic analysis of The Riverway sediment indicated that 12 taxa of invertebrates were found to inhabit the bottom at sampling stations located adjacent to Brookline Avenue and the MBTA's Longwood Station. The benthic community was found to be dominated by pollution tolerant worms.

The next most dominant group of benthic organisms was pollution tolerant midges (fly larvae). Several pollution tolerant species were also found. The following is a summary of the species that have been found in The Riverway.

Arthropods
- Insects
    - Midges (fly larvae)
    - *Gerris sp.* (water strider)
    - Mayfly

Molluscs
- *Physa* and other snail species
- Freshwater clam species

Annelids
- Tubificid Worms
- Leeches

Aquatic vegetation that has been observed in The Riverway includes fanwort (*Cabomba caroliniana*), Pickerelweed (Pontederia cordata), duckweed (*Lemna minor*), water meal (*Wolffia*), and filamentous algae.

The ACOE also conducted testing of the sediment from The River to determine its bio-toxicity. The test results indicated that there was a significant impact on the survival and growth of the amphipod (a bottom dwelling organism) test species. There was no impact on the survival or growth of the test fish species, the fathead minnow.

Fish Resources

Information on fish resources in The Riverway is available from the ACOE data (US Army Corps of Engineers, Appendix D, July 1996) as well as from sampling that was conducted as part of the Wildlife Habitat Evaluation and Vegetation Assessment (see Appendix D). The fish that have been found in The Riverway include the following:

Red Fin Pickerel	*Esox sp.*
Brown bullhead	
Yellow Bullhead	
Pumpkinseed	*Lipomis gibbosus*
Golden shiner	*Notemigonus crysoleucas*
Goldfish	*Carassius sp.*
Common carp	*Cyprinus carpio*

Although observed in Leverett Pond in 1995 and 1996, the blue back herring, an anadromous fish that migrates from the ocean into freshwater to spawn with the juveniles then returns to the ocean, has not been observed in the Riverway.

In 1990, the Massachusetts Division of Fisheries and Wildlife conducted PCB analyses on the tissue of fish that had been collected from the Riverway and Back Bay Fens. The tests indicated that PCBs were contained in the edible tissue of the fish above the USDA Action Level and a Public Health Advisory was issued.

4.4.2.2 Wildlife Resources

The wildlife resources of the Riverway include avian and non-avian species that have been observed through on-site observations that were conducted as part of this project's Wildlife Habitat Evaluation and Vegetation Assessment (see Appendix D). Wildlife species that have been observed at and around The Riverway include the following:

Birds

American Crow	*Corvus brachyrhyncos*
American Robin	*Turdus migratorius*
Black Duck	*Anas rubpies*
Black and White Warbler	*Mniotilta varia*
Blue Jay	*Cyanocitta cristata*
Canada Goose	*Branta canadensis*
Common Grackle	*Quiscalus quiscula*
Downy Woodpecker	*Picoides pubescens*
English Sparrow	*Passer domesticus*
European Starling	*Sturnus vulgaris*
Mallard	*Anas platyrhynchos*
Mourning Dove	*Zenaida macroura*
Northern Cardinal	*Cardinalis cardinalis*
Northern Flicker	*Calaptes auratus*
Pigeons	*Columba spp.*
Red-winged Blackbird	*Agelaius phoeniceus*
Wood Duck	*Aix sponsa*

4.4.2.3 Rare Species

The Massachusetts Natural Heritage and Endangered Species Program was consulted (see Appendix K). Endangered, Threatened Rare species are not reported to inhabit the Riverway.

4.4.2.4 Wetland Resources

The wetland resources at The Riverway were delineated during the spring and summer of 2000. An Abbreviated Notice of Resource Area Delineation (ANRAD), which contained the wetland delineation plans, was presented to the Boston and Brookline Conservation Commissions and accepted by both Commissions in September 2000. A description of the methodology that was used to delineate the wetlands around The Riverway is provided in Appendix B.

The wetland delineation at The Riverway resulted in the following resource area findings:

Bank	12,670 sf
Land Under Water	373,047 sf
Vegetation growing in Land Under Water	44,087 sf
Bordering Vegetated Wetland	31,537 sf

The following wetland plants were found to inhabit the Riverway and its adjacent areas:

Riverway

common reed	*Phragmites communis*
purple loosestrife	*Lythrum salicaria*
speckled alder	*Alnus rugosa*
glossy buckthorn	*Rhamnus frangula*
northern arrowwood	*Viburnum regnium*

4.4.2.5 Ecological Functions and Values

An Ecological Functions and Values analysis was conducted by following the US Army Corps of Engineers Highway Methodology (Supplement, November 1995). The purpose of the Functions and Values analysis is to provide as non-biased an assessment of the habitat and wildlife as possible. The results of the functions and values analysis of The Riverway are shown in Table 4-14.

The Riverway area extends from Route 9 to the Back Bay Yard. A continuous footpath parallels the eastern and western sides of the river south of Route 9. The majority of areas landward of the footpath are vegetated by a mature tree canopy and manicured lawn areas that occupy the groundcover to the river's banks.

Wetlands along the Riverway have been invaded by Common Reed (*Phragmites australis*) and knotweed, which are extremely aggressive and provide a monoculture ecosystem. The *Phragmites* has expanded into the watercourse and constricted the river channel substantially in numerous areas along

Wetland Function-Value Evaluation Form

Total area of wetland______Human made?____Is wetland part of a wildlife corridor?___________or a "habitat island"?

Adjacent land use Park______________Distance to nearest roadway or other development____________

Dominant wetland systems Shrub Contiguous underdeveloped buffer zone present___Nl________

Is the wetland a separate hydraulic system?__No________If not, where does the wetland lie in the drainage basin?______

How many tributaries contribute to the wetland?___1______Wildlife & vegetation diversity/abundance (see attached list)

Wetland I.D.
Latitude______Longitude________
Prepared by:___JLG__Date_10/19/00
Wetland Impact:
Type______________Area________
Evaluation based on:
Office__X__________Field______
Corps manual wetland delineation completed? Yes X____No_______

Function/Value	Occurrence Y	Occurrence N	Rationale (Reference #)*	Principal Function(s)/Value(s)	Comments
Groundwater Recharge/Discharge		X	7		No evidence of groundwater discharge.
Floodflow Alteration	X		4,5,9,12	X	Wetland is able to retain some flood water.
Fish and Shellfish Habitat	X		3,4,6,8,12,17		Fish are present.
Sediment/Toxicant Retention	X		1,3,4,8,9,10,16	X	Wetland is effective in trapping sediments from runoff waters.
Nutrient Removal	X		2,3,4,6,7,8,9	X	Wetland is able to trap nutrients from surrounding uplands.
Production Export		X	1,2		Wetland contains little useable food for living organisms
Sediment/Shoreline Stabilization	X		1,3,5,6,8,9,12		Phragmities are effective in stabilizing the bank.
Wildlife Habitat		X	9,10		Mono-ecosystem, does not provide a diversity for wildlife habitat.
Recreation	X		13		Area is used for passive recreation.
Educational Scientific Value		X			Area is not used for educational value
Uniqueness/Heritage		X	1,2		
Visual Quality/Aesthetics		X			
ES Endangered Species Habitat		X			No endangered species reported in the area
Other					

*Refer to back up list of numbered considerations.

Notes: *=Restoration goals are designed to provide and enhance these functions and values.

Table 4-14
Wetland Function-Value Evaluation Form for The Riverway

The 13 functions and values that are considered by the Regulatory Division for any Section 404 wetland permit are listed below. The list includes eight functions and five values. Values are grouped together at the end of the list.

These are not necessarily the only wetland functions and values possible. Not are they so precisely defined as to be unalterable. However, they do represent the best working 'palette' of descriptors, which can be used to paint an objective representation of the wetland resources associated with a proposed project.

▼ **Groundwater Recharge/Discharge**--This function considers the potential for a wetland to serve as a groundwater recharge and/or discharge area. Recharge should relate to the potential for the wetland to contribute water to an aquifer. Discharge should relate to the potential for the wetland to serve as an area where groundwater can be discharged to the surface.

Floodflow Alteration (Storage & Desynchronization)--This function considers the effectiveness of the wetland in reducing flood damage by attenuation of floodwaters for prolonged periods following precipitation events.

Fish and Shellfish Habitat--This function considers the effectiveness of seasonal or permanent waterbodies associated with the wetland in question for fish and shellfish habitat.

Sediment/Toxicant/Pathogen Retention--This function reduces or prevents degradation of water quality. It relates to the effectiveness of the wetland as a trap for sediments, toxicants or pathogens.

Nutrient Removal/Retention/Transformation--This function relates to the effectiveness of the wetland to prevent adverse effects of excess nutrients entering aquifers or surface waters such as ponds, lakes, streams, rivers, or estuaries.

➡ **Product Export (Nutrient)**--This function relates to the effectiveness of the wetland to produce food or usable products for human, or other living organisms.

Sediment/Shoreline Stabilization--This function relates to the effectiveness of the wetland to stabilize stream banks and shorelines against erosion.

Wildlife Habitat--This function relates to the effectiveness of the wetland to provide habitat for various types and populations of animals typically associated with wetlands and the wetland edge. Both resident and/or migrating species must be considered. Species lists of observed and potential animals should be included in the wetland assessment report.

Recreation (Consumptive and Non-Consumptive)--This value considers the effectiveness of the wetland and associated watercourses to provide recreational opportunities such as canoeing, boating, fishing, hunting and other active or passive recreational activities. Consumptive opportunities consume or diminish the plants, animals, or other resources that are intrinsic to the wetland, whereas non-consumptive opportunities do not.

Education/Scientific Value--This value considers the effectiveness of the wetland as a site for an 'outdoor classroom' or as a location for scientific research or study.

★ **Uniqueness/Heritage**--This value considers the effectiveness of the wetland or its associated waterbodies to produce certain special values. Special values may include such things as archeological sites, unusual aesthetic quality, historical events, or unique plants, animals, or geological features.

Visual Quality/Aesthetics--This value relates to the visual and aesthetic qualities of the wetland.

ES **Threatened or Endangered Species Habitat**---This value considers the effectiveness of the wetland or its associated waterbodies to support threatened or endangered species.
Source: ACOE

Table 4-14

this portion of the River, (i.e. between Brookline Avenue and Jamaicaway, the eastern channel through the Island Bridges area, and the eastern side of the Muddy River between Chapel Street Bridge Area and the Back Bay Yard). Colonization of *Phragmites* increases sediment deposition in affected areas through sediment trapping. Sediment deposition will further impede the ability of the river to carry flow downgradient through coincident decreases in the water column and channel width.

Between Route 9 and Longwood Avenue, there are outcrops of northern red oak (*Quercus rubra*), American elm (*Ulmus americana*), and white ash (*Fraxinus americana*). These provide habitat to avian species as well as small mammals. However, minimal wildlife habitat exists south of Brookline Avenue as the flow in this area is subterranean and upon daylight, the banks are lined with rip-rap. The one area in this segment that is neither subterranean nor rip-rap lined is choked by *Phragmites.*

North of Brookline Avenue, the river bifurcates and rejoins south of Netherlands Avenue. The eastern branch of the channel is choked by *Phragmites* while the western channel is clear. The Riverway islands contain a mature canopy of black oak (*Quercus velutina*), northern red oak (*Quercus rubra*), and pin oak (*Quercus palustris*). The oak trees within this area provide a food source for small mammals.

Downstream of the island bridges area, the man-made channel is perfectly linear and the vegetative cover consists of a mature oak canopy, with manicured lawn groundcover. The shrub layer consists of Japanese knotweed, with scattered individuals of gray birch (*Betula populifolia).* The mature tree canopy shades the watercourse and prevents the colonization of *phragmites* here. Cobble raceways contribute sediment to the river in this area thereby decreasing water quality. The raceways primarily transport stone dust from the walkway paralleling the river.

Between Longwood Avenue and the former Sears Parking Lot, the vegetation is comprised of a mature oak canopy. *Phragmites*, river birch (*Betula nigra*), glossy buckthorn and gray birch (*Betula populifolia*) dominate the bank vegetation. In addition to *phragmites* and Japanese knotweed, yellow iris (*Iris pseudacorus*), an invasive species is present in the northern section of the Riverway. The two densely vegetated islands, located on the eastern side of the Riverway, consist of red maple (*Acer rubrum*), river birch, paper birch, pin oak *(Uercus palustris*) and weeping willow *(Salix baylonica*). The islands increase habitat diversity for aquatic and land animals. In addition, the islands provide a significant refuge for pecies within this segment of the Riverway due to the narrow amount of open space and heavy vehicular traffic at this location.

rincipal wetland functions throughout the Riverway include sediment and floodflow alteration, fish nd shellfish habitat, sediment/toxicant retention, nutrient removal, production export, and ediment/shoreline stabilization.

.4.3 Cultural Environment

4.3.1 Historic Resources

he Riverway area has a Primary Period of Significance of 1880-1895, which is the Frederick Law lmsted design for the area between Brookline Avenue at the Fens to Route 9 in Brookline.

n **1880** Olmsted completed a plan titled "Suggestion for the Improvement of Muddy River, which was ublished in the Sixth Annual Report of the Boston Park Commissioners and in the Annual Report of the Brookline Park Commissioners. The suggested improvement included a diagrammatic plan for the proposed park prior to the 1881 design plan. Frederick Law Olmsted sets forth his intent:

> "*Except where the valley is now narrowest, it would be reduced in width by artificial banks, so that the river with its shores would everywhere have a general character, resembling that which is now has near Longwood Bridge, only that its water would be kept at a nearly uniform level, and guarded from defilement by intercepting sewers and otherwise. The Brookline margin would be the broadened base of the present railroad embankment, bearing a woody thicket. The opposite on Boston bank would have an elevation above the water of ten feet, rising where the natural bank is used to twenty feet [typo?]. Upon this will be laid out a public way ninety feet wide in continuation of that now forming along the Back Bay Basin, divided like that into foot, carriage, and saddle courses, and designed to serve as a public promenade along the river bank, as well as a trunk line giving an element of continuity to the street system of the neighborhood*"

John Charles Olmsted in a 1904 report discussed the issue of a created manmade landscape:

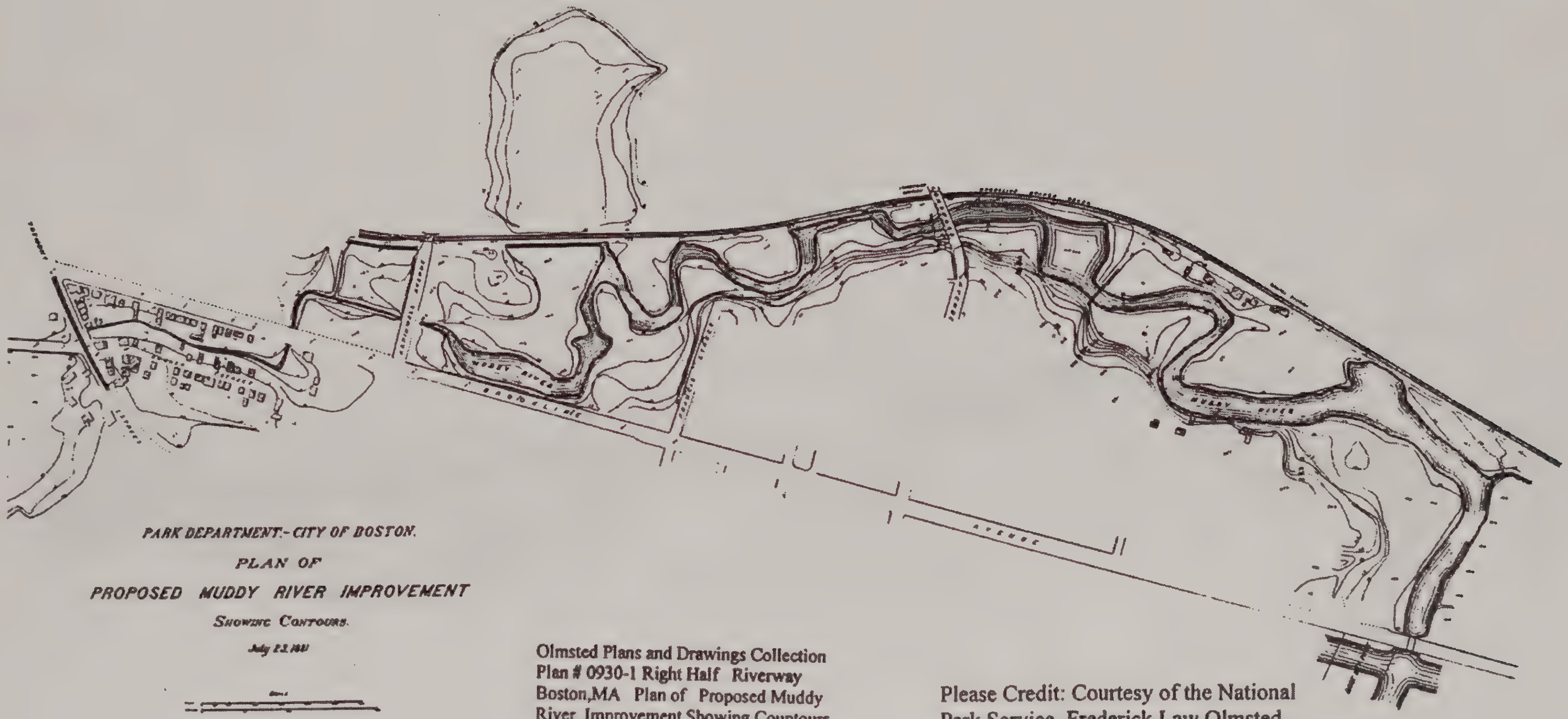
> "*Practically everything seen in this picture, which is typical of many portions of the Riverway, was artificially created in accordance with plans of the designers. Only the larger trees, in the distance and on the left, existed at the time, substantially as they now appear. The various ...were designed in collaboration with different architects. This beautiful and popular water park represents the transformation of what was once an ugly, neglected, and unsanitary stream.*"

A July 23, 1881 survey titled "Plan of Proposed Muddy River Improvement Showing Contours," prepared by Boston City Engineer Henry M. Wrightman, documented the site prior to the commencement of Olmsted's work. The Riverway site was in fact part of the estuary of the Muddy River and contained salt marsh grasses and salt-water resistant shrubs. It was impacted by runoff water, a public health problem, and was a generally derelict area. The creation of the park required a change to the boundary between Boston and Brookline transferring the new boundary principally down the center of the river (see Figure 4-33).

The **1892** lithograph titled "Plan of the Parkway between Muddy River Gate House and Jamaica Park", and the **1896** "Plan of Portion of Park System from Common to Franklin Park" document the park during the Olmsted Period. In addition, a series of plans dating 1890 to 1893 provide detailed proposed grading, historic shoreline, plant massings with viewsheds, plant lists, and planting plans for the Olmsted design.

The 1892 design plan illustrates a winding fresh-water stream described by Olmsted as "*fresh water course bordered by passages of rushy meadow and varied slopes from the adjoining upland; trees in groups diversified by thickets and open glades*". (See Figure 4-34.)

Olmsted's design intent was to create a landscape with the character of a New England fresh water stream. The entire streamway was re-graded and replanted to produce a landscape that, while appearing natural, was the product of careful design, engineering, and construction. Both the Olmsted firm's plans and historic photographs show how completely the site was transformed in the process.


PARK DEPARTMENT.- CITY OF BOSTON.
PLAN OF
PROPOSED MUDDY RIVER IMPROVEMENT
Showing Contours.
July 23, 1881
MUDDY RIVER
MUDDY RIVER
AVENUE

Olmsted Plans and Drawings Collection
Plan # 0930-1 Right Half Riverway
Boston,MA Plan of Proposed Muddy
River Improvement Showing Countours
July 23, 1881

Please Credit: Courtesy of the National
Park Service, Frederick Law Olmsted
National Historic Site.

Figure 4-33
Plan of Proposed Muddy River Improvements Showing Contours, July 23, 1881
Source: FLONHS

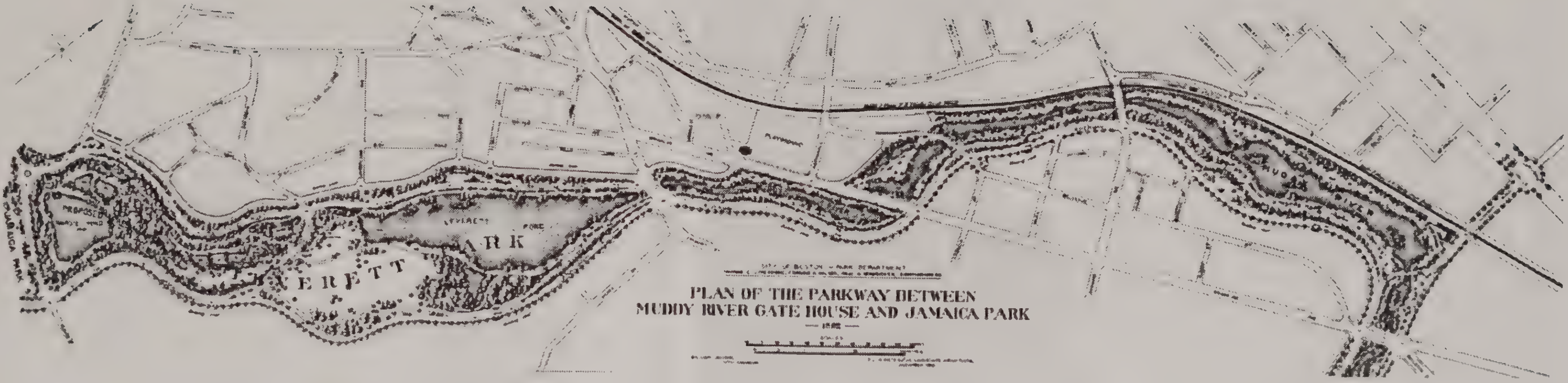

PLAN OF THE PARKWAY BETWEEN
MUDDY RIVER GATE HOUSE AND JAMAICA PARK
— 1892 —
ERETT
ARK
JAMAICA PARK
MUDDY RIVER

Figure 4-34
Plan of the Parkway Between the Muddy River Gate House and Jamaica Park, 1892
Source: FLONHS

Although the basis of Olmsted's plantings was the trees, shrubs, and ground cover of the region, he supplemented them with non-native plants in order to enrich the landscape effect and produce a more powerful experience. The dominant figure on Brookline park commission was Charles S. Sargent, with whom Olmsted had collaborated in planning the Arnold Arboretum. Sargent objected to Olmsted's proposal to use non-native plants, as well as plants that Sargent considered too floral and ornamental. Accordingly, Sargent removed a number of plants from Olmsted's list in the spring of 1892, some of which were restored. The Olmsted firm's less detailed planting plans and lists for the Boston side of the Muddy River reflect their desire to use a wider range of plant materials than Sargent would permit on the Brookline side, while retaining an overall unity of landscape character between the two sides of the river (see Figure 4-35).

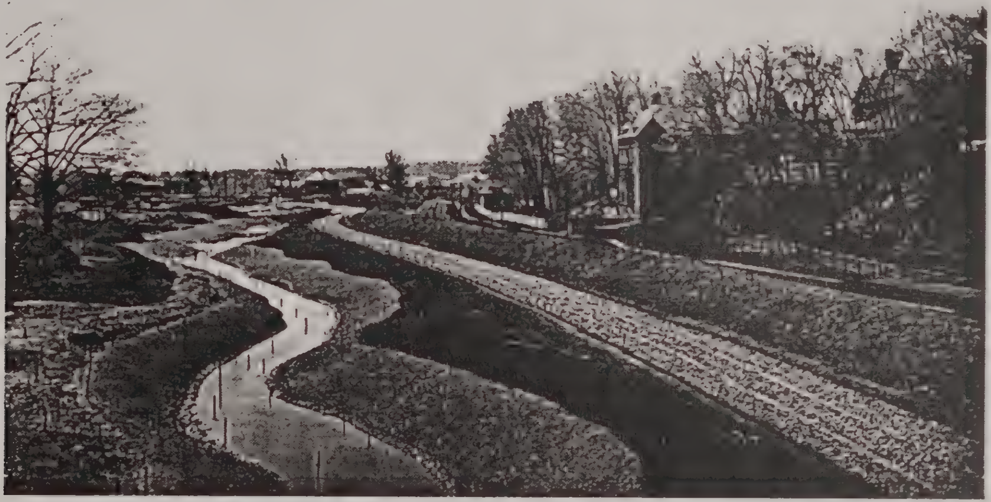


Figure 4-35
Riverway Under Construction, 1892
Source: FLONHS

Extensive photographic documentation exists for the park, starting with construction photographs in 1891 and 1892 and continuing up to 28 years after its completion. These photos illustrate how the shoreline of the river was constructed and how the plantings and original bank treatments, either planted or grass beaches, progressed down to the edge of emergent vegetation (see Figure 4-36).

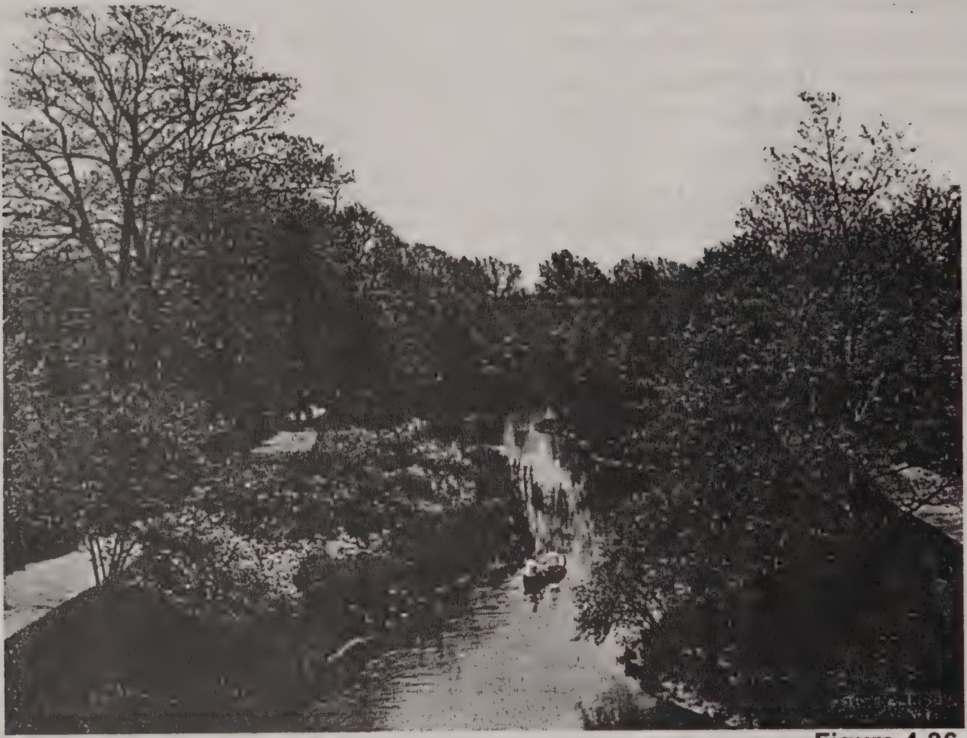


Figure 4-36
View Upstream from Longwood Bridge, 1920 (28 years after construction)
Source: FLONHS

Complete grading plans that delineate the grading and layout of the original shoreline have been examined. Overlaying the shoreline for the Primary Period of Significance with existing conditions aids in determining what area of shoreline is extant from that period. Extensive drawings exist which document the planting that occurred over the grading plan areas, including massing and viewshed diagrams, planting plans, and the above mentioned plant lists. Drawings of the Brookline side show detailed plant placement, while the documentation of the Boston side illustrates massings with general lists of species to be planted. No other park designed by Olmsted firm during Olmsted's career and with his active participation has nearly as detailed a record of planting intent. The conceptual involvement and detailed plans for the Muddy Rive also shows intensive involvement by John C. Olmsted, who carried on the firm's work in Boston parks after Olmsted's retirement in 1895, and by Warren Manning, the firm's chief plantsman, who had a notable landscape design career of his own beginning in the late 1890's.

The planting plans and plant list for the entire Boston side of the Muddy Rive and Olmsted Park have been identified and brought together for the first time during the present project. They indicate plant materials not used on the Brookline side that were supplement to those lists. They also indicate the particular conditions of soil and sun and shade under which different groups were to be used. The Boston-side plans are less detailed than those for Brookline, since Olmsted and his firm usually preferred to make many planting decisions in the field as the process went on. William L. Fisher supervised the planting on the Boston side for the Olmsted firm. He preferred to locate plants in the field rather than do detailed planting plans (see Figure 4-37).

Olmsted designed the park as a scenic picturesque park, with activities that were compatible with enjoying the scenery. As with the Back Bat Fens, Olmsted constructed a circular system along the

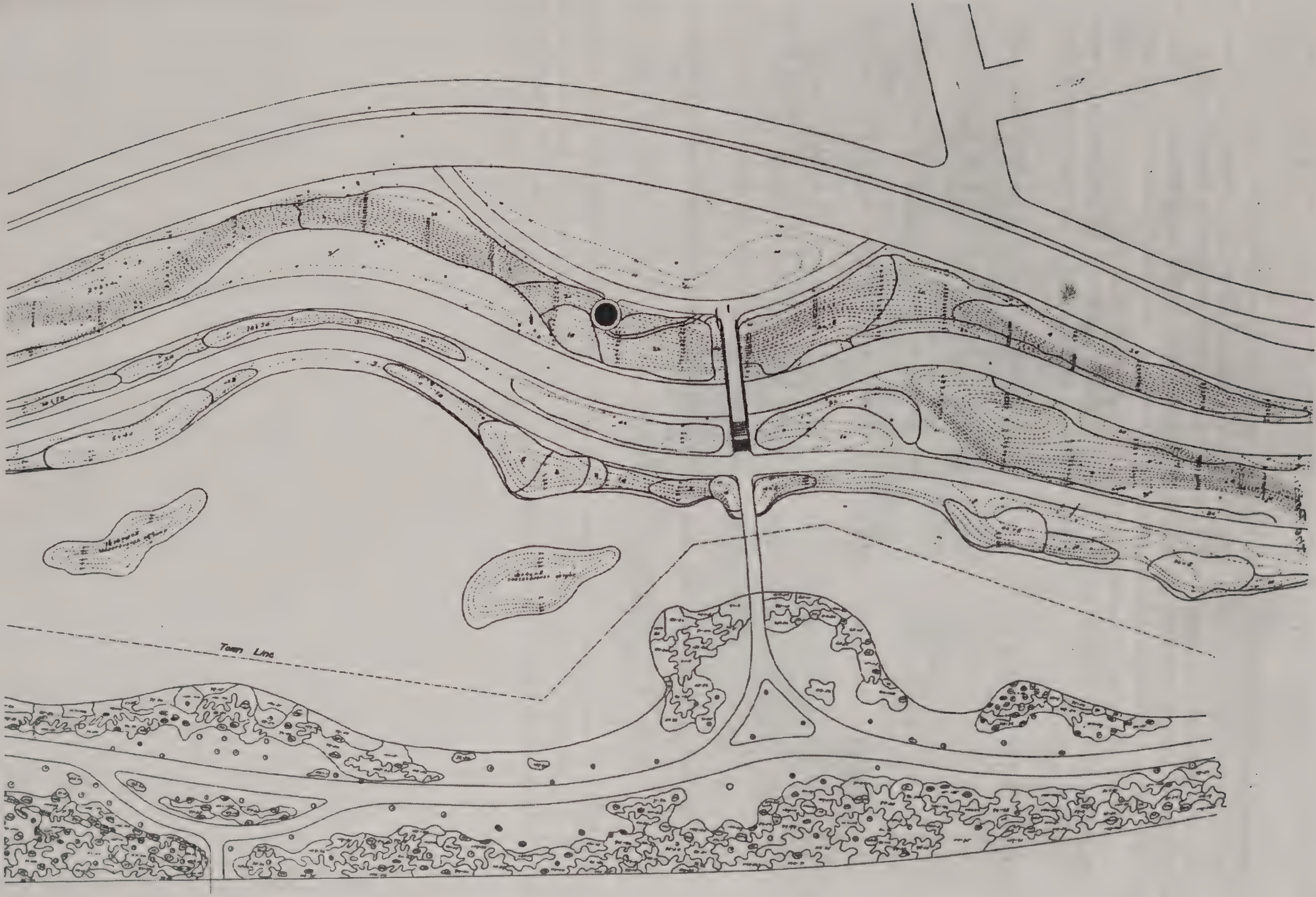


Figure 4-37
Riverway, Topographic Plan for Planting Study, 1893
Source: F.L. Olmsted

Muddy River as a part of transformation of the site to serve the purpose of a public park. The path systems and the separation of carriage, horse, and foot traffic were the major features that allowed three categories of users to enjoy scenery without causing physical danger or interfering with the experience of the landscape of each. Olmsted also intended to have the river accessible to canoes. We have photographic documentation of a canoe landing at gatehouse near Brookline Avenue. The design included nine bridges that interfaced with the river and either provided viewing points or were features set in picaresque views. Several of the bridges and culverts were built under a cooperative arrangement between the city and town. The bridges included:

- the Audubon Bridal Bridge, which provided for foot and street traffic as well as horseback riding;
- the Chapel Street Bridge over the railroad tracks for foot traffic;
- the Chapel Station Bridge, a footbridge over the river;
- the Bridal Path Bridge, a combined footbridge with an equestrian underpass for the bridal path;
- the Longwood Bridge, for street traffic but which included a stair connection on the Brookline side to the park below;
- the Bellevue Street (Netherlands Road) Bridge for street traffic;
- two footbridges in the island area between Netherlands Road and Brookline Avenue; and
- the Bridge at Brookline Avenue in Brookline for vehicles, which actually is a culvert.

Olmsted also introduced three structures to the design: a round stone shelter above the Bridal Path Bridge, an Administration Building near the Audubon Bridge for Boston, and a Gatehouse at Brookline Avenue in Boston to divert Muddy River overflow to the Charles River. The gatehouse and associated conduit were completed in 1883 (see Figure 4-38).

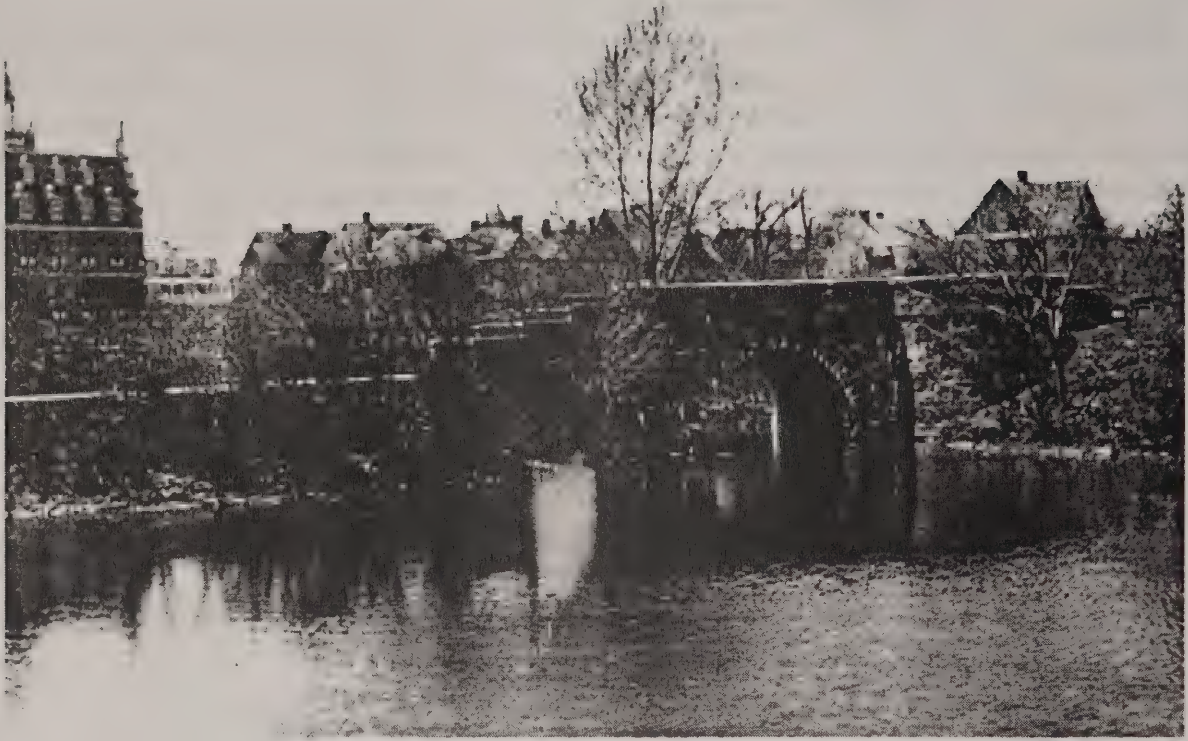


Figure 4-38
Riverway Footbridge near Brookline Ave., at Netherlands Rd., 1920
Source: FLONHS

There is no Secondary Period of Significance since there has been no major designer involved in the Riverway since Frederick Law Olmsted's involvement, although the Olmsted Firm did some consulting afterwards. In 1897 John A. Pettigrew was hired as Park Superintendent for the Boston side, following which the contract with the Olmsted Firm was not renewed.

Cynthia Zaitzevsky, in her book, Frederick Law Olmsted and the Boston Park System, states that between 1895 and 1930, the Riverway escaped the massive redesigns of the Back Bay Fens and the removal of original design elements that occurred in the upper part of Olmsted Park to the south. Although modifications occurred, they were generally limited to alterations to the planting. The Riverway, unlike the Fens and Olmsted Park, was not suited to active recreation and organized sports due to its narrowness and terrain, and thus was insulated from these intrusions.

The Parkways were not insulated from such intrusions. In the 1930s parkland takings began when the Tremont Street (Route 9) overpass was constructed, impacting the southern end of the Muddy River and its connection to Olmsted Park. From 1934-1949, proposals to construct a rotary at the intersection of Audubon Road (Park Drive) and the northern end of the Riverway were initiated. From 1951-1955 proposals for a by-pass road at the Riverway and Audubon Road were considered. Between 1953 and 1959 parkland was taken for road widening, right-hand turn only lanes, exit and entry ramps, and parking.

During this time commuter traffic continually increased, isolating the Riverway within a major roadway system. This resulted in the gatehouse, Audubon Bridal Bridge and headwalls at Brookline

Avenue being demolished. The Muddy River was filled and culverted, and the parkways around the park were widened and reconfigured. In 1958-1959 the taking of land above the Fens at Brookline Avenue resulted in relocation of the boat launch and filling to construct the Sears Roebuck Company parking lot.

These actions severed the Riverway from the Fens, negatively impacting pedestrian movement, the equestrian ride, and the canoeing activity in the Riverway. The equestrian system was impacted so dramatically by the roadway widening and right hand turn only lanes at Longwood Bridge and Brookline Avenue that it was virtually eliminated.

In 1956 the MDC assumed care and control of the Riverway, including a twenty-five (25') foot taking of a right of way into the parkland.

The Riverway was built as a sanitary improvement and has never been dredged, although the system has been impacted by the neighboring drainage and sewerage systems. The banks are undermined and plantings that originally stabilized the banks, including wetland bank, upland, and canopy plantings principally are non existent, having been replaced by volunteer tree and shrub growth and extensive invasive herbaceous species. Cynthia Zaitzevsky noted in her report, Riverway Historic Landscape Report, January 1987, that on October 6, 1962, floodwater was discharged through the MBTA tunnels via the new Fenway Park opening and that between 1963 and 1964 two flood control projects were undertaken by the MDC. The projects included dredging the Muddy River from the southerly end of Leverett Pond to Park Drive and installing new culverts as well as constructing a new dike system.

In 1971 the Riverway was placed on the National Register of Historic Places under the National Preservation Act of 1966, along with all of Olmsted's Emerald Necklace Parks and Parkways On October 24, 1989, The Riverway was designated a landmark by the City of Boston, under Chapter 772 of the Acts of 1975.

Projects completed in the Riverway since the adoption of the Emerald Necklace Master Plan are documented in the Emerald Necklace Master Plan contained herein.

A list of Historic Plans and Plant Lists for the Riverway Area is contained in the Appendix C.

4.4.3.2 Land Use

The Riverway land uses are divided primarily between residential and institutional but include a small commercial area. The properties along the eastern length of the Riverway are predominately institutional, but include one or two residential properties. On the western side, the MBTA rail track runs immediately adjacent to the park from the City of Boston municipal building at Park Drive to Netherlands Road. The MBTA Longwood stop with support parking is located along the western side. Just beyond the rail track, the properties are residential land use until Netherlands Road, where there is a Town of Brookline municipal building. Moving south from Netherlands Road is a residential area followed by a playground, another municipal building, terminating with a series of commercial buildings at Route 9.

The land that is immediately adjacent to The Riverway is a maintained grassy parkland with paved and unpaved paths, and a mixture of mature Olmsted-planted trees as well as younger trees and some bushes. The Riverway roadway runs parallel along its east side and the MBTA Green Line tracks run along the west side until Netherlands Road where local Brookline streets are present.

4.4.3.3 Recreation

Olmsted designed the park as a scenic picturesque park, with activities that were compatible with enjoying the scenery. The pedestrian circulation system along the Muddy River is extant, but the equestrian canoeing activities are no longer functional. The current paths used are used for walking, biking, and running. There are also benches for sitting and viewing.

4.4.3.4 Pedestrian Access

Current pedestrian conditions within The Riverway segment of the project study area extending from the Sears Rotary (the Riverway at Brookline Avenue/Boylston Street) to the intersection of The Riverway at Brookline Avenue were examined. Figure 4-39 provides a depiction of this area. In comparison to the Charlesgate and Back Bay Fens areas, there are fewer recreational opportunities in the park through The Riverway area. Pedestrian demands in this area are predominantly crossing the park rather than destined for the park. The most notable pedestrian flows in this area are between the residential areas of Brookline and the MBTA station to the west of the Riverway and the Longwood Medical Area to the east of the Riverway.

Pedestrian demands were collected on key sidewalks and crosswalks at the Sears Rotary, at Longwood Avenue, along Netherlands Road, and at Brookline Avenue in July 2000 from 8:00 AM to 6:00 PM on a weekday with amenable weather and coinciding with a Red Sox home game. It should be noted that at the time these counts were taken, only a portion of the Landmark Center development at the Sears Rotary was constructed and occupied. The majority of the retail space (Bed Bath & Beyond and Staples) and the cinema had recently opened prior to these counts. Table 4-15 provides a summary of the observed pedestrian demands. Figure 4-39 provides a graphical depiction of these demands.

Table 4-15
Pedestrian Volume Summary – The Riverway Area

Sidewalk	Morning Peak Volume (peds per hour)	Evening Peak Volume (peds per hour)
Sears Rotary Area-Diagonal path From Brookline Avenue	25	120
Sears Rotary Area – sidewalk along Brookline Avenue adjacent to the Rotary	20	55
The Riverway at Longwood Avenue – north and south crosswalks	955	785
Netherlands Road	30	50
The Riverway at Brookline Avenue - East and west crosswalks	215	160

Source:Pedestrian counts conducted by VHB in July 2000.
1. These counts were taken in May 1999.

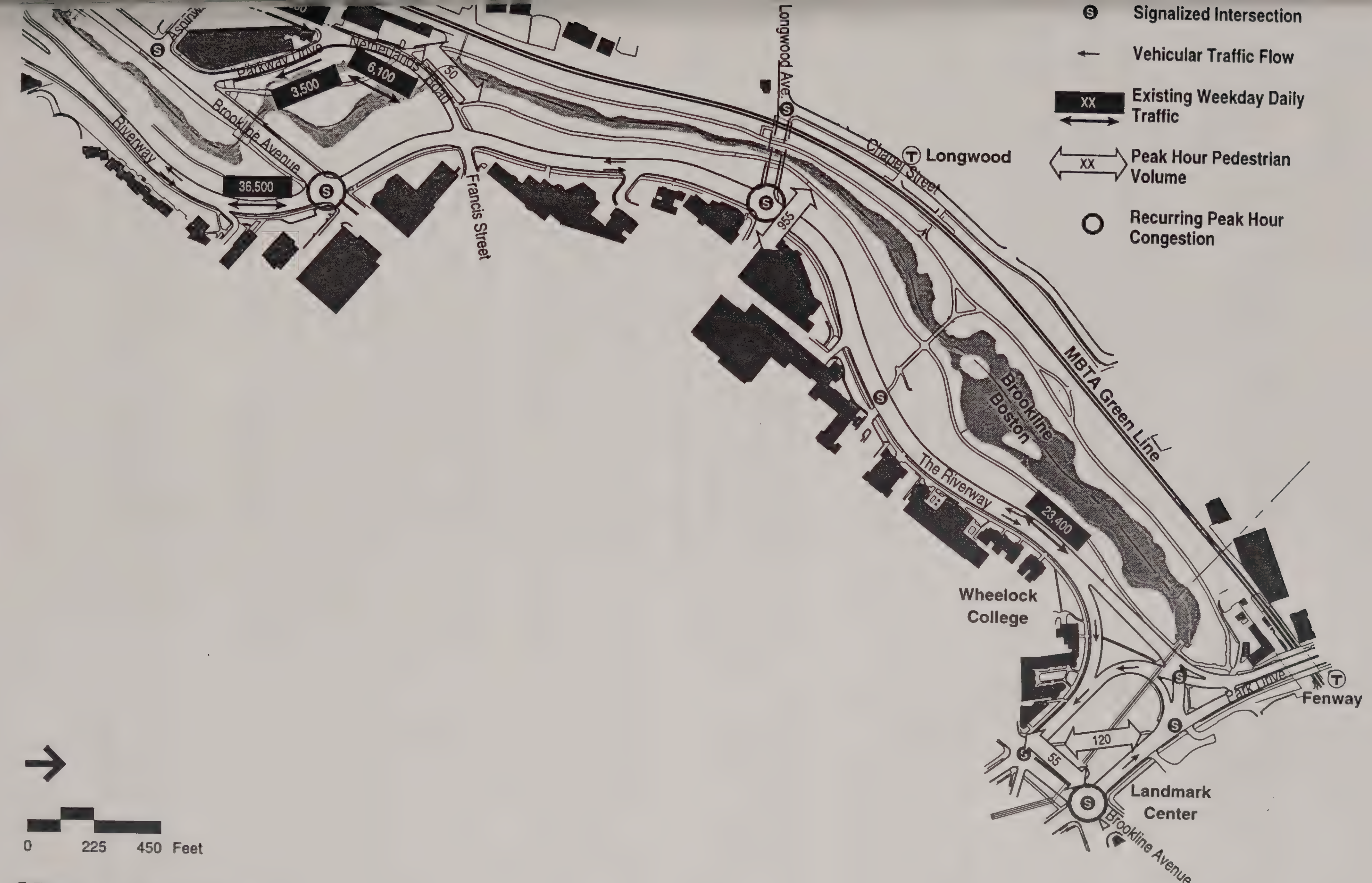


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Figure 4-39
Muddy River Restoration
Riverway Area Existing Conditions

Source: VHB, Inc.

General observations indicate that the pedestrian demands near the rotary are influenced significantly by Red Sox home games. There is a surge in demand just prior to, and after the ballgame. However, these peak periods do not coincide with a typical construction schedule since most weekday ballgames begin after 7:00 PM.

By far the heaviest pedestrian demands through this area are across The Riverway at Longwood Avenue. In the morning peak hour (at about 8:00 AM), 955 pedestrians crossed The Riverway at Longwood Avenue. In the evening (at about 5:00 PM), 785 pedestrians crossed The Riverway. The majority of these pedestrian demands are between the Longwood Medical Area and the MBTA Green Line station on Longwood Avenue, located just west of this intersection. At the Sears Rotary, the majority of the pedestrian activity is focused near the MBTA Green Line Station.

There were 215 pedestrians observed crossing The Riverway at Brookline Avenue in the morning and 160 pedestrians in the evening. The pedestrian demands at other observed locations are somewhat lower. Within the Sears rotary, there were 25 pedestrians in the morning peak hour and 120 pedestrians in the evening peak hour. Along Brookline Avenue at the rotary, there were 20 pedestrians in the morning peak hour and 55 pedestrians in the evening peak hour. Along Netherlands Road there were no more than 50 pedestrians per hour.

In this portion of The Riverway area, the majority of the sidewalks are concrete and in good condition. At the heavily used crossings across the Riverway at Longwood Avenue and The Riverway at Brookline Avenue, the traffic signals at these intersections are equipped with an exclusive pedestrian crossing phase. At these intersections, there is a notable accumulation of pedestrians waiting for the crossing phase during the morning and evening peak periods.

This area of The Riverway also is well served by public transit. The pedestrian demands through this area are influenced by nearby MBTA stations. There are two nearby Green Line subway stations located at the Sears Rotary (the Fenway Station on the D Line) and on Longwood Avenue (the Longwood Medical Area Station on the E Line). The MBTA bus routes 8, 60, 65, and CT-3 provide service to this area. These bus routes service the area through existing stops along Brookline Avenue.

Counts of bicyclists were conducted concurrent with the pedestrian counts. There are no designated bicycle lanes in this area. Along The Riverway, the vehicular travel lanes are narrow and bicyclists tend to use the existing sidewalks rather than the travelway for safety reasons. There were less than 10 bicyclists per hour observed along the Riverway. T here was somewhat higher bicycle activity at the Sears Rotary. Bicycle counts conducted north of the Sears Rotary on Brookline Avenue indicate that approximately 15 to 25 bicyclists cross Brookline Avenue during an average weekday morning peak hour, mid-day peak hour or evening peak hour. Bicycle counts conducted north of the Sears Rotary on Boylston Street indicate that approximately 15 to 20 bicycles cross Boylston Street during an average weekday morning peak hour, mid-day peak hour or evening peak hour. The existing crosswalk widths and signal timing provisions appear to be adequate to process the existing bicycle volumes.

4.4.4 Traffic

The examination of traffic conditions in the Riverway area of the project was focused on an area extending from the Sears Rotary to the intersection of the Riverway at Brookline Avenue. Park Drive, the Fenway, the Riverway, Boylston Street and Brookline Avenue merge to form the Sears Rotary. The

Riverway parallels the Muddy River between Brookline Avenue and terminates at its intersection with the Fenway. West of the Fenway, the Riverway is bi-directional. It becomes one-way in the southerly direction, south of Park Drive.

The Riverway is a 4-lane roadway that is heavily traveled with notable congestion at several intersections. The Riverway is an MDC roadway that is restricted to passenger vehicles only. The Riverway is a major commuter route connecting Jamaica Plain, West Roxbury, Dedham and points southwest to downtown Boston, the Longwood Medical Area, and Back Bay. It should be noted that at the time these counts were taken, only a portion of the Landmark Center development at the Sears Rotary was constructed and occupied. The majority of the retail space (Bed Bath Beyond and Staples) and the cinema had recently opened prior to these counts. Table 4-16 and Figure 4-39 present the weekday traffic demands along The Riverway and Netherlands.

Table 4-16
Traffic Volume Summary - The Riverway Area

Roadway	Morning Peak Hour Volume (vph) [1]	Evening Peak Hour Volume (vph)	Weekday Daily Volume (vpd) [2]
The Riverway northbound - south of Park Drive	835	790	11,000
The Riverway southbound – south of Park Drive	600	1,100	12,400
The Riverway northbound – south of Brookline Avenue	900	610	11,400
The Riverway southbound – south of Brookline Avenue	1,870	2,050	25,100
Netherlands Road eastbound – at the Riverway	365	45	2,600
Netherlands Road westbound – at the Riverway	150	400	3,500

Source: Traffic counts conducted by VHB in July 2000.
1. Peak hour volume, expressed in vehicles per hour (vph).
2. Daily volume, expressed in vehicles per day (vpd).

The Riverway is a heavily traveled roadway, carrying approximately 11,000 vpd in the northbound direction and 12,400 vpd in the southbound direction between Park Drive and Brookline Avenue. Traffic demands increase on The Riverway south of Brookline Avenue, reaching 25,100 vpd in the southbound direction and 11,400 vpd in the northbound direction. Netherlands Road carries approximately 6,100 vehicles daily. Observations indicate that Netherlands Road is frequently used as a bypass of the traffic signal at The Riverway and Brookline Avenue.

Using the traffic data that were collected, the weekday peak hour periods through the Riverway Area were estimated. The morning peak occurs between 7:00AM and 8:00 AM and the evening peak hours occurs between 5:00 PM and6:00 PM. These intervals are based on hourly traffic demand fluctuations along the Riverway, south of Brookline Avenue, on a typical weekday (this portion off the Riverway carries the heaviest traffic demands through this area).

There are existing capacity deficiencies at several locations along The Riverway from the Sears Rotary to Brookline Avenue. These are:

- ***Brookline Avenue at The Riverway*** - There are notable demands at this intersection from both The Riverway and Brookline Avenue that are not efficiently handled by the traffic signal and the existing geometry (LOS F operations). Moreover, the northbound right-turn lane on The Riverway is not adequately delineated, resulting in safety issues with through vehicles inadvertently using the right-turn lane. There is also an operational issue associated with the inadequate vehicle storage for left-turns from Brookline Avenue westbound onto The Riverway southbound. The heavy left-turn demand and the inadequate storage result in left-turning vehicles attempting to turn from the middle lane which is designated for through traffic.

- ***Longwood Avenue at The Riverway*** - There are notable demands on the intersection from both Longwood Avenue and The Riverway that cannot efficiently be handled by the traffic signal and the existing geometry (LOS F operations). There are also heavy pedestrian demands at this intersection requiring a separate, exclusive crossing phase.

- ***Boylston Street/Park Drive at Brookline Avenue*** – This signalized intersection operates poorly (LOS F operations) in the morning and evening peak periods. High demands at all approaches entering the intersection create excessive delays. (This deficiency also is noted under section 4.3.4).

4.5 Leverett Pond

4.5.1 Physical Environmental Features

Leverett Pond is located in that portion of the Emerald Necklace called Olmsted Park. Leverett Pond is bordered by grassed parkland for most of its perimeter. There is a natural shoreline on the Boston side (east) and a gabion formed shoreline for the majority of the Brookline side. Roadways around Leverett Pond include Route 9 (south side), the Jamaica Way (east side), Willow Pond Road (south side) and Riverdale Parkway (west side). Leverett Pond contains three islands along its western side. The Pond is shallow (3 feet) and has a large sand bar from the largest stormwater outfall into the Muddy River, the Village Brook Drain (2,060 acres) (see Figure 4-40).

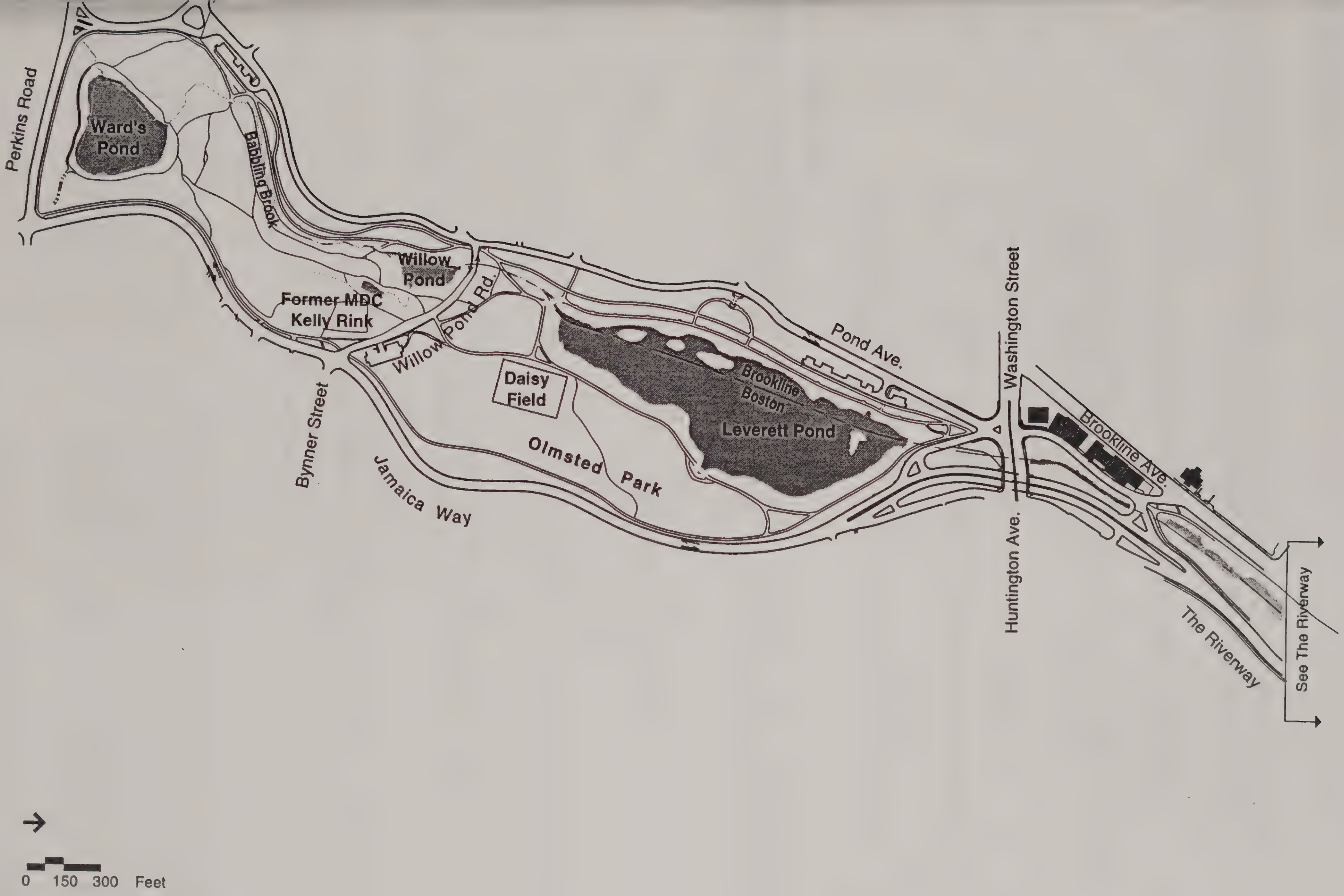


Figure 4-40
Olmsted Park
Source: VHB, Inc.

The Village Brook Drain has been a large source of sediment to the Pond since the late 1800s. Historical records indicate that it has been necessary to dredge Leverett pond approximately every 30 years. The dredging history is as follows:

1898-1899	The sand bar was removed from in front of the Village Brook Drain.
1930	The sand bar was removed and the dredging comprised an area of 150 feet south of the drain inlet. The Pond was left at a depth of 1-3 feet with a 3.5 foot deep center channel.
1943	The sand bar had reappeared and was mapped for tracking.
1963	The entire pond was dredged to a depth of 5 feet from the existing 0.5-1.0 feet.
1980	Dredging of the sand bar was budgeted by Brookline but the dredging reportedly never occurred.

4.5.1.1 Hydrology

Leverett Pond, located upstream of Route 9 at the upstream end of The Riverway, has two major drains contributing stormwater flows, Village Brook and Daisy Field Drains. The following describes the contribution from these drains during the October 1996 storm:

Drain	Drainage Area (mi^2)	Peak Flow (cfs)	Volume (MG)
Village Brook	3.21	797	237
Daisy Field	0.07	36	9.9

Containing 3.21 square miles, the Village Brook drainage area is the largest area contributing to the Muddy River via Leverett Pond.

The normal water surface elevation during dry-weather flow in Leverett Pond is about 8.0 ft BCB, which, as described in earlier sections, is the same elevation as the downstream portions of the Muddy River and the Charles River.

Peak elevation in Leverett Pond during the October 1996 storm is about 19.43 ft BCB. While the HGL in the pond itself is flat, the water surface elevation rises from the Route 9 bridge, where it is about 18.93 ft BCB, to the 19.43-ft elevation in the pond. This rise in elevation is due to minor head loss in the open channel sections between Route 9 and the pond itself.

4.5.1.2 Sediment Quality

The Leverett Pond borings (summer 2000) were completed to a maximum depth of fourteen feet below the top of sediment or until native material was encountered. The general stratigraphy encountered consisted of varying thickness (2 to 8 ft) of a soft, black, organic silt, intermixed with fine to coarse sand and gravel. Pockets of organic material were observed in the upper limits (0 to 4 ft) of sediment at a few boring locations. The native material underlying the silt layer typically was observed at two to eight feet below the top of the sediment. Native material consists of grey, loose to medium dense, fine to medium sand with varying amounts of fine gravel and silt. The exception to the above native description is within the southern portion of Leverett Pond where the native material contained soft, grey clay with varying amounts of silt. Pockets of peat were observed within the native material at the northern limits of the Pond. Petroleum odors were present at one boring location (LP-SED-26) which appears to be associated with a pocket of organic material in that area.

The C_9 to C_{12} aliphatic hydrocarbons of the VPH scan were found more frequently than the other carbon ranges and typically at higher concentrations. The concentrations of the carbon ranges generally decreased with depth. The concentrations of VPH were higher in samples collected from the center to the outlet of Leverett Pond. Naphthalene and toluene were found at low levels in the surficial samples collected from locations LP-SED-22 and LP-SED-24. The results for the EPH scan were all below the DEP landfill reuse level of 2,500 mg/kg except at LP-SED-17 that contained EPH at 2,500 mg/kg in the 0 to 2 ft sample. Total PAHs above 100 mg/kg were found at several locations along Leverett Pond. The results above 100 mg/kg in samples collected from 0 to 2 ft included LP-SED-2 at 131 mg/kg, LP-SED-9 at 107 mg/kg, LP-SED-12 at 112 mg/kg, LP-SED-20 at 114 mg/kg, and LP-SED-24 at 155 mg/kg. Samples collected from LP-SED-20 at the 2 to 4 ft interval, LP-SED-21 and LP-SED-24 at the 4 to 6 ft interval also were above 100 mg/kg at concentrations of 131 mg/kg, 120 mg/kg and 133 mg/kg, respectively.

PCBs were detected in several samples from Leverett Pond however the concentrations were below the 2 mg/kg limit. As found with the other areas sampled, only aroclor 1254 and aroclor 1260 were found above detectable levels. The results for pesticides show that 4,4′-DDD, 4,4′-DDE and 4,4′-DDT were found in samples of the fill material in most of the samples analyzed. The highest concentration of 8.3 mg/kg was found at location LP-SED-25 in the sample collected from native material at a depth of 12 to 14 feet. Other locations with elevated concentrations include LP-SED-7 (5.4 mg/kg), LP-SED-11 (2.8 mg/kg) and LP-SED-17 (3.1 mg/kg). The concentrations of pesticides found at Leverett Pond were the highest in comparison to the other study areas.

Analyses for metals showed elevated levels of lead and arsenic at several locations. Locations where samples were above 1,000 mg/kg total lead include LP-SED-4, LP-SED-11, LP-SED-13, LP-SED-16, LP-SED-17, LP-SED-18, and LP-SED-26. These locations extend the length of Leverett Pond and are generally centered within the pond. None of the samples analyzed exceeded the regulatory limit for TCLP lead. The locations of samples where arsenic was above 40 mg/kg include LP-SED-2, LP-SED-11, LP-SED-12, and LP-SED-13. The concentrations ranged from 42 mg/kg to 51 mg/kg.

Samples were also analyzed for reactive cyanide and sulfide. Reactive cyanide was not detected in any of the samples analyzed. Reactive sulfide was found above the 500 mg/kg regulatory limit in the sample collected at LP-SED-25 from 0 to 2 ft at a concentration of 1,300 mg/kg. Two samples were collected for analysis of the paint filter test. The results showed that free liquids were not present. The results of samples collected at Leverett Pond are summarized in Table 4-17.

Table 4-17
Summary of Sediment Analytical Results - Leverett Pond

Contaminant	No. of Samples	Concentration [1] Minimum	Concentration [1] Maximum	DEP Landfill Reuse Levels [1] Unlined	DEP Landfill Reuse Levels [1] Lined	No. of Samples Exceeding Unlined	No. of Samples Exceeding Lined
Total Arsenic	67	ND	51	40	40	5	5
Total Cadmium	67	ND	6.6	30	80	No Exceedances	
Total Chromium	67	5	400	1000	1000	No Exceedances	
Total Lead	67	5.6	1700	1000	2000	9	None
TCLP Lead (mg/L)	30	ND	4	NA	NA	No Exceedances	
Total Mercury	67	ND	1.7	10	10	No Exceedances	
Total EPH	67	ND	2500	2500	5000	1	None
Total PCBs	33	ND	1.07	<2	<2	No Exceedances	
Total PAHs	67	ND	187	100	100	8	8
Total VPH	67	ND	32	NA	NA	No Exceedances	
Total VPH Target	67	ND	1.1	4	10	No Exceedances	
Reactive Sulfide	33	ND	1300	500		1	1
Reactive Cyanide	33	Not Detected		250		No Exceedances	
pH	33	5.1	7.7	2 < pH < 12.5		No Exceedances	
Conductivity	33	73	1500	4000 umhos/cm	8000 umhos/cm	No Exceedances	

[1] All results are reported in mg/kg unless otherwise noted.

The methodology for the sediment test program, analytical results, and summary figures are included in Appendix F.

Elutriate analyses were conducted on sediment from Leverett Pond in order to determine, if during the process of hydraulic dredging, if any toxic metals could be released to the environment. The metals that were analyzed included those that are required by the ACOE and the MA DEP, i.e. antimony, arsenic, beryllium, cadmium chromium, copper, lead, mercury, nickel, selenium, silver, thallium, zinc. In the elutriate analysis procedure, sediment is mixed with water at the same general ratio as would occur during hydraulic dredging, i.e. 1 part of sediment to 5 parts of water. The sediment and water are mixed, filtered, and tested. The receiving water is also tested for the same constituents. The difference in concentrations indicate the magnitude of the toxins that could be released during the dredging. The sample location(s) that were selected were done so because the results of the bulk sediment characterization indicated high levels of contamination. An elutriate analysis was conducted on sediment that was collected from the outlet of Leverett Pond (sediment sample LP Sed 26, on sediment that was collected from a location that is adjacent to the Village Brook Drain sandbar (sediment sample LP Sed 13, and on sediment that was collected from a location that is near Daisy Field (sediment sample RW Sed 4). These sediment sample locations are shown on Figure F2-5A in Appendix F. The tests on sediment sample LP Sed 26 resulted in the release of 0. 0.011 mg/l of arsenic. The concentration of arsenic that was released is below the acute and chronic freshwater water quality criteria of 0.360 mg/l and 0.190 mg/l, respectively. The tests from sediment samples LP 13 and LP 4 did not result in a release of toxic metals.

4.5.1.3 Water Quality

Water from Willow Pond enters on the southern end of Leverett Pond and exits to form the Riverway at the northern end of Leverett Pond. There is one substantial outfall, the Village Brook Drain, which enters Leverett Pond on the west side near the Pond's outlet. This outfall drains approximately 57% of the Muddy River watershed (2,060 acres). Records indicate that Leverett Pond was dredged in 1898-1899, and in 1930 to remove a sandbar in front of the Village Brook Drain. In 1963, the entire pond was dredged from an existing depth of 0.5-1.0 feet to 5 feet. Presently, sediment has re-entered Leverett Pond and has reduced its depth to 3 feet ±. A large sand bar is clearly visible adjacent to the Village Brook Drain and is approximately1.5 feet above the water surface.

The Massachusetts Department of Environmental Protection (DEP) has established Water Quality Standards for all waters in the Commonwealth. The Muddy River watershed has been classified as Class B waters. As such, Class B waters are considered swimmable and fishable.

In order to assess the water quality of Leverett Pond, a review of the water quality history was conducted and water was sampled and tested as part of this project. Historical water quality data is from the:

Division of Water Pollution Control (now the MA DEP)	1981
Division of Water Pollution Control (now the MA DEP)	1986
Army Corps of Engineers	1992
Northeastern University	1995
Charles River Watershed Association (CRWA)	1998

The historical data indicated that bacteriological water quality standard (<200 bacteria per 100 ml of water), and/or the dissolved oxygen water quality standards(>5 mg/ml and>75% of saturation) were not met in 1986, 1992, 1995, and 1998 (temperature, dissolved oxygen and pH were not tested by the CRWA). While testing diurnal oxygen dynamics in the Muddy River, Northeastern University found that the dissolved oxygen was below the Class B water quality criteria. The water quality of Leverett Pond did meet the temperature(<20°C) and pH(6.6-8.3 units) standards during those years.

Although the Water Quality Standards do not have numeric criteria for suspended solids, nitrogen and phosphorus, certain limnological (the study of freshwater ecology) water quality values were applied to the Muddy River because of its lotic (slow moving) character. These were 20 milligrams per liter (mg/l) for total suspended solids (TSS), 0.30 mg/l for inorganic nitrogen (the summation of nitrate, nitrite, and ammonia nitrogen forms), and 0.01 mg/l for total phosphorus. Applying these values against the historical data, it was noted that excessive nutrient conditions occurred in Leverett Pond during 1992, 1995, and 1998.

The Village Brook Drain (see Figure 4-41) is the largest of the stormwater discharges in the project area. It drains approximately 2,060 acres and transports 57 percent of the runoff in the watershed. The drain discharges into Leverett pond just upstream of the Route 9 bridge. Historical water quality data on the Village Brook Drain indicates that the only time the water quality standard for fecal coliform bacteria was not being met was during 1986. Total suspended solids, inorganic nitrogen and total phosphorus water quality values were elevated during the 1998 CRWA testing.

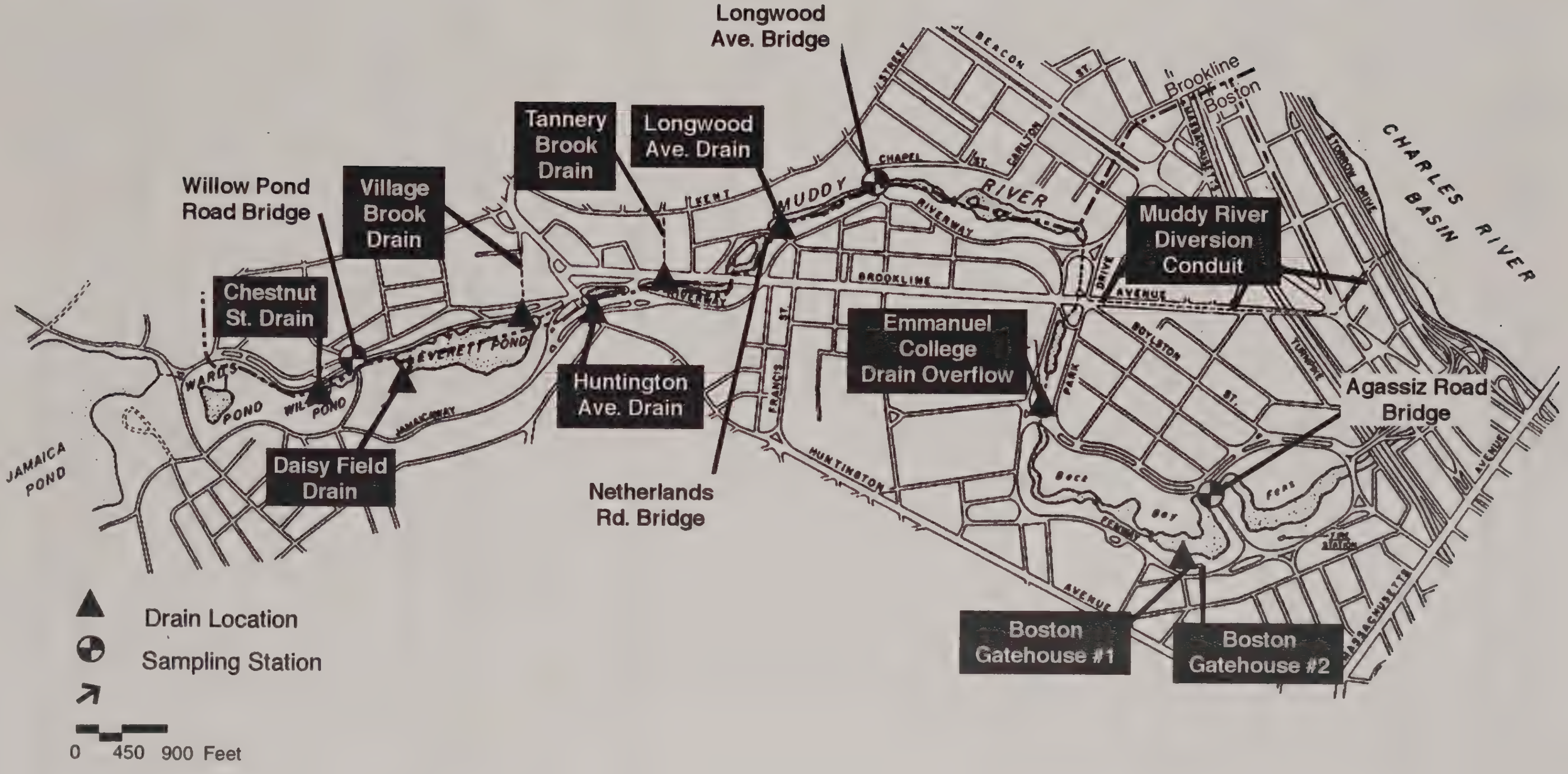


Figure 4-41
Muddy River Sampling Stations
Source: BPRD

On October 4 (dry weather condition), October 6 (wet weather conditions) and December 14 (wet weather conditions the water quality of the Village Brook Drain was analyzed for the following parameters:

Temperature	Nitrate plus Nitrite Nitrogen
Dissolved Oxygen (DO)	Ammonia Nitrogen
pH	Total Phosphorus
Turbidity	Fecal Coliform Bacteria
Total Suspended Solids (TSS)	Fecal Streptococcus Bacteria
True and Apparent Color	

The results of the Village Brook Drain water quality indicated the following conditions during dry and wet conditions.

Water Quality Parameter	**Dry Weather**	**Wet Weather**
Temperature	P/P/P	P/P/P
Dissolved Oxygen (DO)	P/P/P	P/P/P
PH	P/P/P	P/F/P
Total Suspended Solids (TSS)	P/P/P	P/P/P
Inorganic Nitrogen	F/F/F	F/F/F
Total Phosphorus	F/F/F	F/F/F
Fecal Coliform Bacteria	P/P/P	F/F/F

P-Pass
F-Fail
P/F/F- Pass dry weather (October 4)/Fail wet weather (October 14)/ Fail wet weather (December 14, 2000)

The water quality report is contained in Appendix G.

The dissolved oxygen concentrations were high during dry and wet weather and were present at 115 percent of saturation during dry weather and 85 percent during wet weather. The dissolved oxygen concentrations were determined in the field by using calibrated dissolved oxygen meters. The high percent saturation level was verified through Winkler titration.

As shown by the alkalinity value, the water in the Village Brook Drain adds buffering capacity against downward changes in pH with alkalinity values averaging 35 mg/l. The water in the drainage was found to contain a somewhat alkaline pH (7.8 units). The turbidity and total suspended solids levels were low. There was no indication of humic materials in the water as the true and apparent color values were essentially the same. The inorganic nitrogen and phosphorus concentrations during dry weather were slightly higher than would be desired. They increased several-fold during wet weather. Fecal coliform bacteria in the Village Brook Drain were very low or not detected during either dry or wet weather. In keeping with EPA guidance, the Massachusetts Department of Environmental Protection is developing guidelines for nutrient limitations where the technology based point and non-point source pollution controls are not stringent enough to meet the water quality standards. These guidelines are planned to be issued in 2003.

In 1995 the Town of Brookline entered into a Consent Agreement with the US Environmental Protection Agency to investigate and remove illicit sewage connections to the Muddy River drainage system, which included the Village Brook Drain. As a result of these investigations, 39 sources of sewage equivalent to 185 dwelling sources were located and subsequently removed. Some sewer separation work was also underway during the autumn of 2000. There were also some inter-municipal connections from Boston to Brookline where sewage was being discharged to the drainage system. Boston has corrected many of these problems and the work is continuing. This leaves only stormwater as the main water source in the drainage system. Boston has corrected many of these problems and the work is continuing.

Continuing projects in Boston include; the implementation of the Boston Catch Basin Improvement Project, the elimination of illegal sanitary connections to storm drains, stormwater management programs, infiltration/inflow controls, catch basin stenciling, public education programs, permitting of large sewer users and regulation of industrial discharges, permitting of new or retrofitted building project through the BWSC's Site plan Review procedure, other NPDES-related compliance efforts. These programs have resulted in substantial water quality improvements by reducing the very high bacterial contamination that past data show existed. Both municipalities operate used motor oil collection centers and collect hazardous wastes. The street sweeping and catch basin cleaning programs in both municipalities will be increased.

4.5.2 Biological Environment

The environment surrounding Leverett Pond approximates a maintained urban park more than an unattended urban woodland. Therefore, the biological resources reflect this setting. The following sections include information on the existing woodlands, horticultural resources and aquatic and wildlife resources and wetlands.

4.5.2.1 Upland Vegetation and Horticultural Resources

The inventory, documentation, and analysis of vegetation in the Leverett Area were completed in August of 2000. The area includes the watercourse from Route 9 to Willow Pond Road. The scope of work includes trees, shrubs, vines, and lawn areas including notation of areas of bare lawn and erosion.

Vegetation breakdown under trees includes:
Deciduous trees - indicating species, caliper and condition
Evergreen trees - indicating species, caliper and condition
Woodland

Vegetation breakdown under shrubs includes:
Restored planting with five years of restoration
Shrub massings
Invasive plant colony - indicating species

Erosion includes:
Bare lawn

Wash outs of storm sewers
Desire lines
Overuse compaction
Surface roots of trees

Analysis of Existing Vegetation is contained in Table 4-18

Table 4-18
Inventory and Analysis of Existing Vegetation - Leverett Pond

Category	Unit	Total	Good	Fair	Poor	Dead
Trees:						
Canopy tree	each	685	180	406	89	10
Flowering tree	each	62	3	52	7	0
Evergreen tree	each	1	1	0	0	0
Heritage tree[1]	each	57	12	31	14	0
Total Trees:		**805**	**196**	**489**	**110**	**10**
Shrubs:	(Estimated)					
Restored planting	square footage	15,142				
Shrub massing	square footage	8,451				
Total Shrubs:		**23,593**				
Invasive Plant Colonies:	(Estimated)					
Phragmites	square footage	0				
Other Invasives (e.g. Knotwee	(Estimated)	95,820				
Total Invasive Plant Colonies:		**95,820**				
Woodland:	(Estimated)					
	square footage	**287,775**				

[1] Note: A heritage tree is a canopy tree with a 32" or greater caliper. If it is listed as a heritage tree, it will not be listed as a canopy tree.

n accordance with the Commonwealth of Massachusetts Department of Environmental Management tandards, trees that are 32" inches in caliper and over are considered to be heritage trees. All trees ave their species and caliper size identified and the condition of the heritage trees is rated as good, fair r poor as are all other trees on the site. The diameter of the circle for tree canopy is in relation to its aliper size.

lan documentation is contained in the Appendices in the form of annotated Existing Conditions Plans.

.5.2.2 Aquatic and Wildlife Resources

everett Pond is a warm water Pond due to the temperature of water from Willow Pond, natural eating, and its inherent shallow depth. The water in Leverett Pond appears turbid as a result of algae growth and suspended sediments. Existing biological resources data that were reviewed was taken from the US Army Corps of Engineers (ACOE) Appendix D, July 1996, as supplemented by information acquired during a Wildlife Habitat Evaluation and Vegetation Assessment of Leverett Pond conducted during this project (Appendix D.)

Benthic Aquatic Resources

Aquatic benthic resources consist of those organisms, which, through part or all of their life cycles, inhabit the bottom of the resource area. Because of their long-term contact with the bottom sediments and water, the benthic community typically reflects the chemical quality of the sediments and water.

Benthic organisms range from those that are pollution intolerant and which inhabit only the cleanest bottom deposits to those that are pollution tolerant species, which inhabit contaminated sediments. Depending on water and sediment quality, the benthic community in ponds may consist of various species of fly larvae (e.g. true flies, caddisflies, may flies, stoneflies, dragonflies, etc.), worms, leeches, various species of crustaceans, snails and other species. The benthic community serves as a food source for such bottom feeding fish as the carp, suckers and goldfish, and smaller forage fish species. Ducks and geese also feed upon these organisms.

The surface sediment in Leverett Pond (see Section 4.5.1.2 – Sediment Quality) was found to contain high concentrations of petroleum hydrocarbons, polynuclear aromatic hydrocarbons and heavy metals. The ACOE's benthic analysis of Leverett Pond sediment indicated that 12 taxa of invertebrates inhabit the bottom. The benthic community was found to be dominated by pollution tolerant worms. The next most dominant group of benthic organisms was pollution tolerant midges (true flies). The following is a summary of the species that either have been found in Leverett Pond or are expected to be present.

Arthropods
- **Insects**
  - Tubificid Worms
  - Chironomids (fly larvae)
  - Gerris (water strider)
  - Caddisfly larvae
- **Crustaceans**
  - Amphipods (scuds)
  - Isopods
  - Decapods (crayfish)

Annelids
- Leeches

Molluscs
- Physa and other snails
- Freshwater clam species

Aquatic vegetation that has been observed in Leverett Pond includes fanwort (Cabomba caroliniana), Pickerelweed (Pontederia cordata), duckweed (Lemna minor), water meal (Wolffia), and filamentous algae

The ACOE also conducted testing of the sediment from Leverett Pond to determine its bio-toxicity. The test results indicated that there was a substantial and significant impact on the survival of the amphipod (a bottom dwelling organism).

Fish Resources
Information on fish resources in Leverett Pond is available from the ACOE data (US Army Corps of Engineers, Appendix D, July 1996) as well as from sampling that was conducted as part of the Wildlife Habitat Evaluation and Vegetation Assessment (see Appendix D). The fish that have been found in Leverett Pond include the following:

Large Mouth Bass	*Micropterus salmoides*
Large Mouth Bass	*Micropterus salmoides*
Pickerel	*Esox sp.*
Brown bullhead	*Ameirurus Nebulosus*
Yellow perch	*Perca flavascens*
Bluegill	*Lepomis macrochirus*
Pumpkinseed	*Lipomis gibbosus*
American eel	*Anguilla rostrata*
Common Shiner	*Notropis cornutus*
Golden shiner	*Notemigonus crysoleucas*
Goldfish	*Carassius sp.*
Common carp	*Cyprinus carpio*
White sucker	*Catostomus commersoni*

Blue back herring, an anadromous fish, which migrates from the ocean into freshwater to spawn with the juveniles then return to the ocean, was observed in May-June of 1995 and 1996.

The ACOE found that the sediments of Leverett pond did not have a significant impact on the survival of the fathead minnow, the test organism.

Wildlife Resources
The wildlife resources of Leverett Pond include avian and non-avian species that have been observed through on-site observations that were conducted as part of the Wildlife Habitat Evaluation and Vegetation Assessment. (See Appendix D). Wildlife species that have been observed at and around Leverett Pond include the following:

Birds

American Crow	*Corvus brachyrhynchos*
American Robin	*Turdus migratorius*
Baltimore Oriole	*Icterus galbula*
Black duck	*Anas rubpies*
Canada Goose	*Branta canadensis*
Cedar Waxwing	*Bombycilla cedrorum*
Common Grackle	*Quiscalus quiscula*
Double-crested coromorant	*Phalacrocorax auritus*
Eastern Kingbird	*Tyrannus tyrannus*
English Sparrow	*Passer domesticus*
European Starling	*Sturnus vulgaris*
Gray Catbird	*Dumetella carolinensis*
Herring Gull	*Laurs argentatus*
Mallard	*Anas platyrhynchos*

Mourning Dove	*Zenaida macroura*
Northern Cardinal	*Cardinalis cardinalis*
Northern Mockingbird	*Mimus polyglottos*
Pigeons	*Columba spp.*
Red-winged Blackbird	*Agelaius phoeniceus*
Tree Swallow	*Tachycineta bicolor*

Reptiles

Painted Turtle	*Chrysemys picta*
Snapping turtle	*Chelydra serepentina*

4.5.2.3 Rare Species

The Massachusetts Natural Heritage and Endangered Species Program was consulted (see Appendix K). Endangered, Threatened Rare species are not reported to inhabit Leverett Pond.

4.5.2.4 Wetland Resources

The wetland resources at Leverett Pond were delineated during the spring and summer of 2000. An Abbreviated Notice of Resource Area Delineation (ANRAD), which contained the wetland delineation plans, was presented to the Boston and Brookline Conservation Commissions and accepted by both Commissions in September 2000. A description of the methodology that was used to delineate the wetlands around Leverett Pond is provided in Appendix B.

The wetland delineation at Leverett Pond resulted in the following resource area findings:

Bank	800 lf
Land Under Water	432,159 sf
Vegetation growing in Land Under Water	0 sf
Bordering Vegetated Wetland	7,884 sf

The following wetland plants were found to inhabit Leverett Pond, Spring Pond and the adjacent areas.

Leverett Pond

skunk cabbage	*Symmplocarpus foetidus*
red-osier dogwood	*Cornus stolonifera*
northern arrowwood	*Viburnum regnium*
purple loossestrife	*Lythrum salicaria*
red maple	*Acer rubrum*

4.5.2.5. Ecological Functions and Values

An Ecological Functions and Values analysis was conducted by following the US Army Corps of Engineers Highway Methodology (Supplement, November 1995). The purpose of the Functions and Values analysis is to provide as non-biased an assessment of the habitat and wildlife as possible. The result of the ecological functions and values analysis of the wetland resources around Leverett Pond are shown in Table 4-19.

Leverett Pond - PRESENT

Wetland Function-Value Evaluation Form

Total area of wetland_______Human made?____Is wetland part of a wildlife corridor? __________or a "habitat island"?

Adjacent land use____Recreation____________ Distance to nearest roadway or other development________________

Dominant wetland systems present Scrub Shrub/Emergent Contiguous underdeveloped buffer zone

present__No________

Is the wetland a separate hydraulic system?_No_________If not, where does the wetland lie in the drainage basin?______

How many tributaries contribute to the wetland?_1________Wildlife & vegetation diversity/abundance (see attached list)

Wetland I.D.
Latitude______Longitude________
Prepared by:________Date________
Wetland Impact:
Type______________Area________
Evaluation based on:
Office_____________Field______
Corps manual wetland delineation
completed? Yes______No________

Function/Value	Occurrence		Rationale (Reference #)*	Principal Function(s)/Value(s)	Comments
	Y	N			
Groundwater Recharge/Discharge		X	8, 13		No evidence of groundwater recharge or discharge.
Floodflow Alteration		X	3, 4, 5, 12,		Wetland is not large enough to hold significant amounts of flood waters.
Fish and Shellfish Habitat	X		3, 4, 7, 8, 10, 12, 14, 17.	X	Fish are present in the pond.
Sediment/Toxicant Retention		X	1,2, 5,15		Wetlands are narrow add provide no sediment retention.
Nutrient Removal		X	2, 4, 6, 9		Wetlands are narrow add provide no nutrient retention.
Production Export		X	1, 2, 4, 6, 8, 12,		Wetlands contain little wildlife food value.
Sediment/Shoreline Stabilization	X		1, 3. 5, 9, 15,		Vegetation along the bank has provided stabilization in most areas.
Wildlife Habitat		X	2, 7, 8, 9, 14		Wetland is not buffered, and there is little habitat diversity in vegetation. Wetland does provide habitat to ducks.
Recreation	X		1, 4, 7, 10, 11, 12	X	Wetland is easily accessible, and has some potential to function as educational and recreational area.

Table 4-19
Wetland Function-Value Evaluation Form for Leverett Pond

Function/Value	Occurrence Y	Occurrence N	Rationale (Reference #)*	Principal Function(s)/Value(s)	Comments
Educational Scientific Value		X	3, 8, 9, 10, 12, 13,		Wetland is easily accessible, and has some potential to function as educational and recreational area.
Uniqueness/Heritage		X	1, 3, 8, 9, 10, 14, 16		
Visual Quality/Aesthetics		X	2, 7		Direct view of wetland and open water exist from the roadway.
ES Endangered Species Habitat		X			No endangered species have been found in a portion of this pond
Other					

*Refer to back up list of numbered considerations.

Notes:

The 13 functions and values that are considered by the Regulatory Division for any Section 404 wetland permit are listed below. The list includes eight functions and five values. Values are grouped together at the end of the list.

These are not necessarily the only wetland functions and values possible. Not are they so precisely defined as to be unalterable. However, they do represent the best working 'palette' of descriptors, which can be used to paint an objective representation of the wetland resources associated with a proposed project.

Groundwater Recharge/Discharge--This function considers the potential for a wetland to serve as a groundwater recharge and/or discharge area. Recharge should relate to the potential for the wetland to contribute water to an aquifer. Discharge should relate to the potential for the wetland to serve as an area where groundwater can be discharged to the surface.

Floodflow Alteration (Storage & Desynchronization)--This function considers the effectiveness of the wetland in reducing flood damage by attenuation of floodwaters for prolonged periods following precipitation events.

Fish and Shellfish Habitat--This function considers the effectiveness of seasonal or permanent waterbodies associated with the wetland in question for fish and shellfish habitat.

Sediment/Toxicant/Pathogen Retention--This function reduces or prevents degradation of water quality. It relates to the effectiveness of the wetland as a trap for sediments, toxicants or pathogens.

Nutrient Removal/Retention/Transformation--This function relates to the effectiveness of the wetland to prevent adverse effects of excess nutrients entering aquifers or surface waters such as ponds, lakes, streams, rivers, or estuaries.

Product Export (Nutrient)--This function relates to the effectiveness of the wetland to produce food or usable products for human, or other living organisms.

Sediment/Shoreline Stabilization--This function relates to the effectiveness of the wetland to stabilize stream banks and shorelines against erosion.

Wildlife Habitat--This function relates to the effectiveness of the wetland to provide habitat for various types and populations of animals typically associated with wetlands and the wetland edge. Both resident and/or migrating species must be considered. Species lists of observed and potential animals should be included in the wetland assessment report.

Recreation (Consumptive and Non-Consumptive)--This value considers the effectiveness of the wetland and associated watercourses to provide recreational opportunities such as canoeing, boating, fishing, hunting and other active or passive recreational activities. Consumptive opportunities consume or diminish the plants, animals, or other resources that are intrinsic to the wetland, whereas non-consumptive opportunities do not.

Education/Scientific Value--This value considers the effectiveness of the wetland as a site for an 'outdoor classroom' or as a location for scientific research or study.

Uniqueness/Heritage--This value considers the effectiveness of the wetland or its associated waterbodies to produce certain special values. Special values may include such things as archeological sites, unusual aesthetic quality, historical events, or unique plants, animals, or geological features.

Visual Quality/Aesthetics--This value relates to the visual and aesthetic qualities of the wetland.

ES Threatened or Endangered Species Habitat---This value considers the effectiveness of the wetland or its associated waterbodies to support threatened or endangered species.

Source: ACOE

Leverett Pond is a linearly shaped pond located at the northern end of Olmsted Park, which is highly impacted by passive recreators. The Pond is bounded on the western side by the Riverway, on the east by the Jamaica Way, on the north by Route 9 and on the south by Willow Pond Road.

The Pond is approximately seven acres in size with a maximum depth of approximately six feet. The pond is fed via discharge from Willow Pond. The outlet from Willow Pond consists of a 15′ reinforced concrete culvert under Huntington Ave to the Muddy River. There are approximately 0.181 acres of wetlands around the pond. The Village Brook Drain discharges storm water from the surrounding area into Leverett Pond. Stormwater discharge from this drain has caused a great amount of siltation in the pond that has resulted in the formation of sand bars. In addition, there are eight storm drains, which also discharge into the pond. Overland flow from the worn path systems around the pond and Daisy Field (ball field) also contribute to the pond's siltation.

The areas around the pond are vegetated by manicured lawn of various grasses with a mature tree canopy. In the majority of areas, the manicured lawn extends to the pond's shoreline. Active planting of shrubs in past years along the western side of the pond has replaced lawn cover. The tree canopy is comprised of sugar maple (*Acer saccharum*), pin oak (*Quercus palustris*), sweet gum (*Liquidambar styraciflua*), black cherry (*Prunus serotina*), black oak (*Quercus velutina*), northern red oak (*Quercus rubra*), and box elder (*Acer negundo*). Shrubs consist of purple loosestrife, sweet pepperbush (*Clethra alnifolia*) and arrowwood (*Viburnum dentatum*).

Due to the narrowness of the wetlands around the pond, flood storage or sediment retention is minimal. Passive recreation activities have degraded much of the surrounding native vegetation, therefore, invasive species, such as purple loosestrife, dominate. Principal wetland functions for Leverett Pond include fish habitat and recreation.

The vegetated islands located on the western side of the pond provide good wildlife habitat. Vegetation on the islands consist of river birch (*Betula nigra*), balsam poplar (*Populus balsamifera*), paper birch (*Betula papyrifera*), white ash (*Fraximus americana*), and tupelo (*Nyssa sylvatica*). The narrow channels between the shoreline of the pond and the islands lend to the diversity of habitats available in Leverett Pond for aquatic species. Furthermore, the islands provide excellent habitat for reptiles, amphibians and avian species. This variety of directly impacts habitat diversity leads to species diversity, which was evidenced by the assortment of aquatic species found in Leverett Pond. Intraspecies comparison amongst the species was observed. The preferred habitat for aquatic species within Leverett Pond is hard-bottomed areas adjacent to steep banks.

4.5.3 Cultural Environment

4.5.3.1 Historic Resources

The Leverett Pond area has a Primary Period of Significance, (1880-1895), which is the Frederick Law Olmsted design for the area between Tremont Street (Route 9) in Brookline and Willow Pond Road. In 1880 Olmsted completed the plan for a "Suggestion for the Improvement of Muddy River", which is published in the Sixth Annual Report of the Boston Park Commissioners and in the Annual Report of he Brookline Park Commissioners. The suggested improvement included a diagrammatic plan for the proposed park prior to the 1881 design plan. Frederick Law Olmsted set forth his intent:

> "*Upper Valley of Muddy River -- A chain of picturesque fresh-water ponds, alternating with attractive natural groves and meads.*
>
> *From Tremont Street, south to Jamaica Pond, the waters widen out into pools and ponds, connected by a rapid brook, and, besides the scenery a more varied Parkway, the road on the Boston side has been named Jamaica-way, thus indirectly, by change of name, recognizing the change of landscape character. The public way on the Brookline side is named Brookline Road, the use of the word 'road' being appropriate to its rural character.*" (Note: Tremont Street now Huntington Avenue)

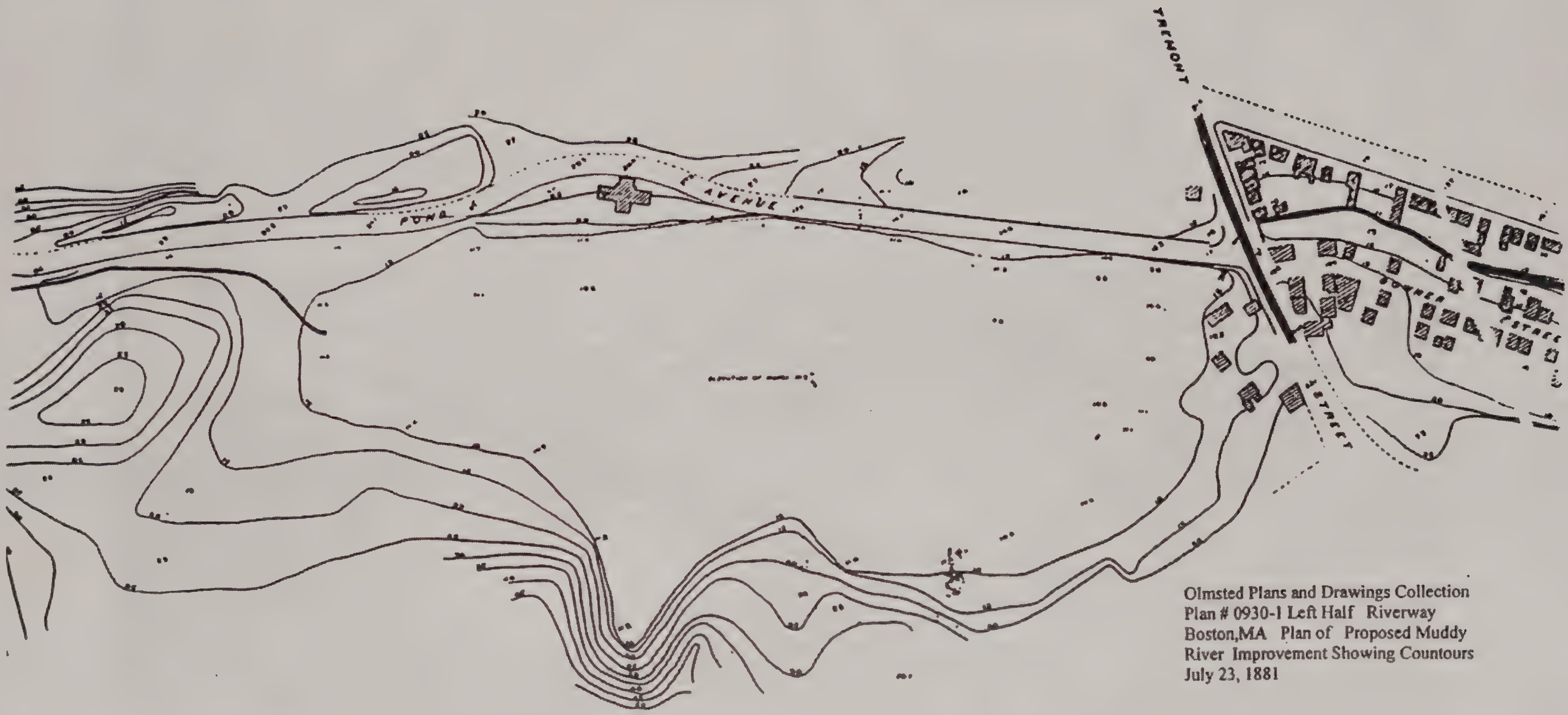
A July 23, 1881 survey titled "Plan of Proposed Muddy River Improvement Showing Contours," prepared by Boston City Engineer Henry M. Wrightman, documents the site prior to the implementation of Olmsted's plan. The Leverett pond site was an existing fresh-water pond that was modified by Olmsted's design. The creation of the park required change to the boundary between Boston and Brookline (see Figure 4-42).

The following decade involved the preparation of several planning efforts including:

- The 1881 "General Plan for the Sanitary Improvement of Muddy River and for Completing a Continuous Promenade between Boston Common and Jamaica Pond",
- The 1889 "Outline of Revised Plan for The Parkway and Sanitary Improvement of Muddy River showing the proposed change in the Town boundary and the relationship of the proposed pleasure ground to the neighboring streets and to the suggested revisions to the railroad arrangements between Chapel and Longwood Stations",
- The 1890 plan published in the Fifteenth Annual Report of the Boston Park Commissioners and the Annual Report of the Brookline Park Commissioners,
- The 1892 lithograph titled "Plan of the Parkway between Muddy River Gate House and Jamaica Park", which increased the site acreage to accommodate a meadow, now Daisy Field,
- The 1896 "Plan of Portion of Park System from Common to Franklin Park" documents the park during the Olmsted Period.

A series of plans dated between 1890 to 1893 provide detailed proposed grading, historic shoreline, plant massings with viewsheds, plant lists, and planting plans for the Olmsted design (see Figure 4-43).

We have limited photographic documentation for the pond. Photographs illustrate how the shoreline of the pond was constructed and the plantings and the original bank treatments; be they planted or turf covered banks coming down to the edge of emergent vegetation. The Olmsted plans and photographs also show the "Olmsted beaches", which were widening of the paths that allowed access to the water edge and were made of the same material as the path. (see Figure 4-44) In Olmsted's period these were gravel paths. The elevation of the water in Leverett Pond is about three feet lower than the elevation shown on Olmsted's grading plans. This has resulted overtime in the change form the banks of the



Olmsted Plans and Drawings Collection
Plan # 0930-1 Left Half Riverway
Boston,MA Plan of Proposed Muddy
River Improvement Showing Countours
July 23, 1881

Please Credit: Courtesy of the National
Park Service, Frederick Law Olmsted
National Historic Site.

Figure 4-42
Plan of Proposed Muddy River Improvements Showing Contours, July 23, 1881
Source: FLONHS

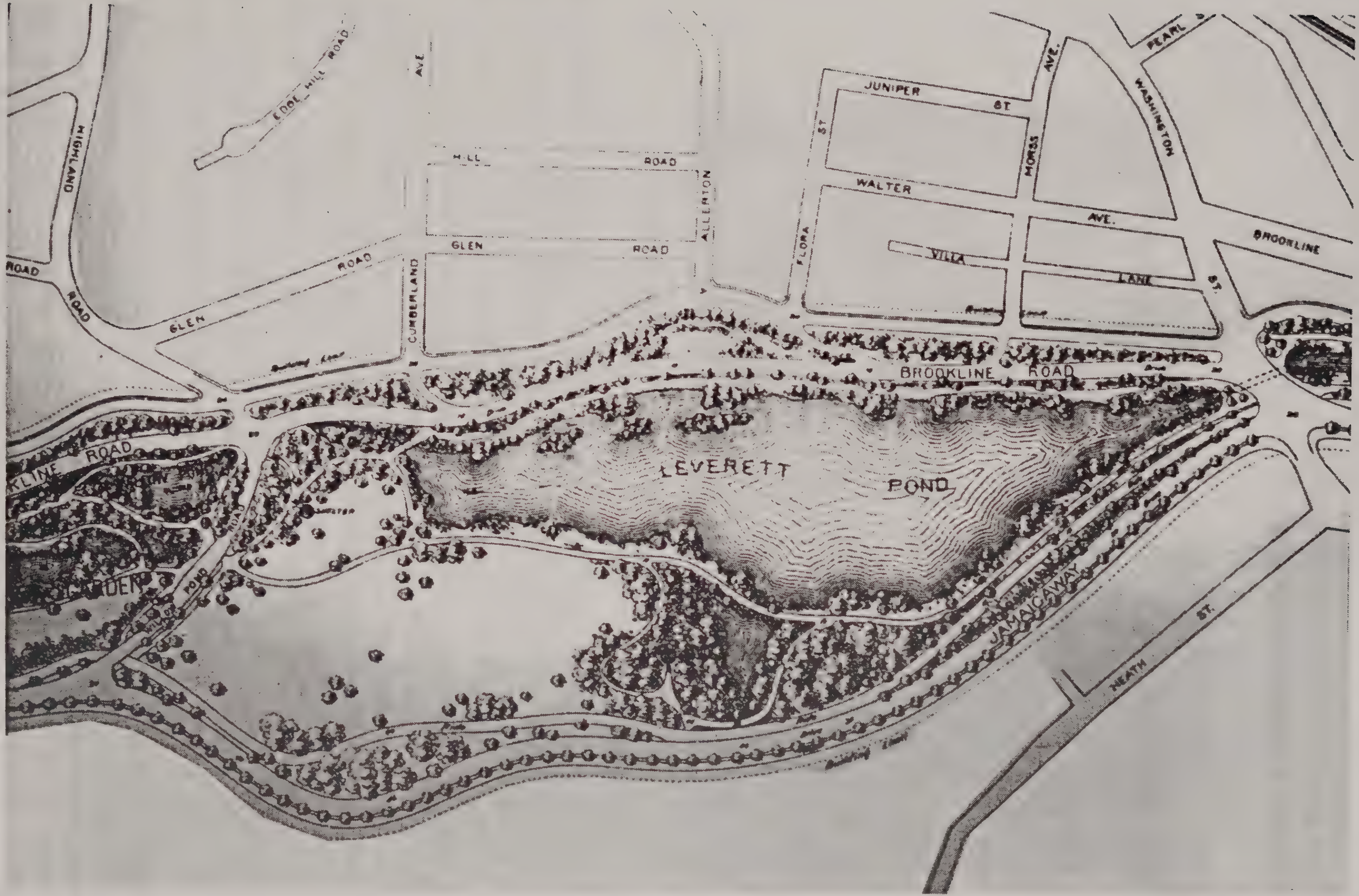


Figure 4-43
Plan of the Parkway Between the Muddy River Gatehouse and Jamaica Park, 1892
Source: FLONHS

original beaches to turf covered banks that extend to the waters edge, since the banks today are too steep to negotiate and stabilize as gravel material. The pond on the Brookline side has a gabion treatment to stabilize the edge, which has resulted in herbaceous plants and shrub and tree seedlings invading the edge, some of which are invasive species. The Boston side has a natural shoreline edge.

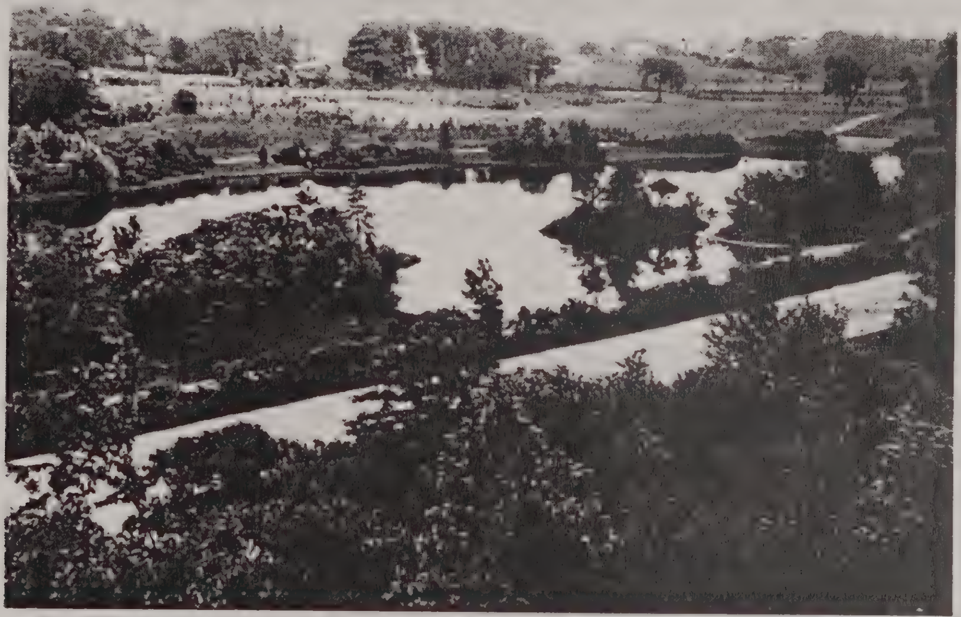


Figure 4-44
View Over Leverett Pond from Allerton Street Overlook, c. 1900
Source:Brookline Public Library

We have complete grading plans exist that delineate the grading and layout of the original shoreline as designed and constructed by Olmsted and his firm in the early 1890's. We can overlaying the plans for the shoreline created during the Primary Period of Significance with surveys showing the existing conditions today, and so determine what areas of shoreline is extant from that period. We also have extensive drawings documenting the planting that was done in Olmsted's time. These include plans showing the intended massing of plant materials and the site direction of dozens of vistas through and over vegetation, providing views up and down and across the river. For Brookline's side there are also detailed plant placement supplemented by extensive planting lists that identify individual trees and plants or groups of plants to be places in precisely indicated areas. No other park designed by the Olmsted firm during Olmsted's career and with his active participation has nearly as detailed a record of involvement by John C. Olmsted, who carried on the firm's work in the Boston parks after Olmsted's retirement in 1885, and by Warren Manning, the firm's chief plantsman , who had a notable landscape design career of his own beginning in the late 1890's.

Olmsted designed the park as a scenic picturesque park, with activities that were compatible wit enjoying the scenery. As with the Back Bat Fen and the Riverway, Olmsted constructed a circulation system around Leverett Pond as a part of his transformation of the site to serve the purposes of a public park. The path systems and the separation of carriage, equestrian and foot traffic were major features that allowed the three categories of users to enjoy the picturesque pond landscape, without causing physical danger or interfering with the experience of the landscape of each. Olmsted also intended to have the pond accessible as canoes. A canoe landing with boathouses was studied for Leverett Pond and a temporary landing was built in 1895, probably at the southern end.

The Cumberland Avenue Bridge was built at the southern end of the pond to cross over the brook feeding into the pond. A second bridge was constructed at the northeast edge to form the cove that today is called the Cove Bridge. Both bridges were stone masonry bridges and allowed for movement through a constantly changing "passage of scenery". It should be noted that the water level in the pond went down, the cove created by Olmsted was no longer feasible and it was filled, but the bridge remains today (see Figure 4-45).

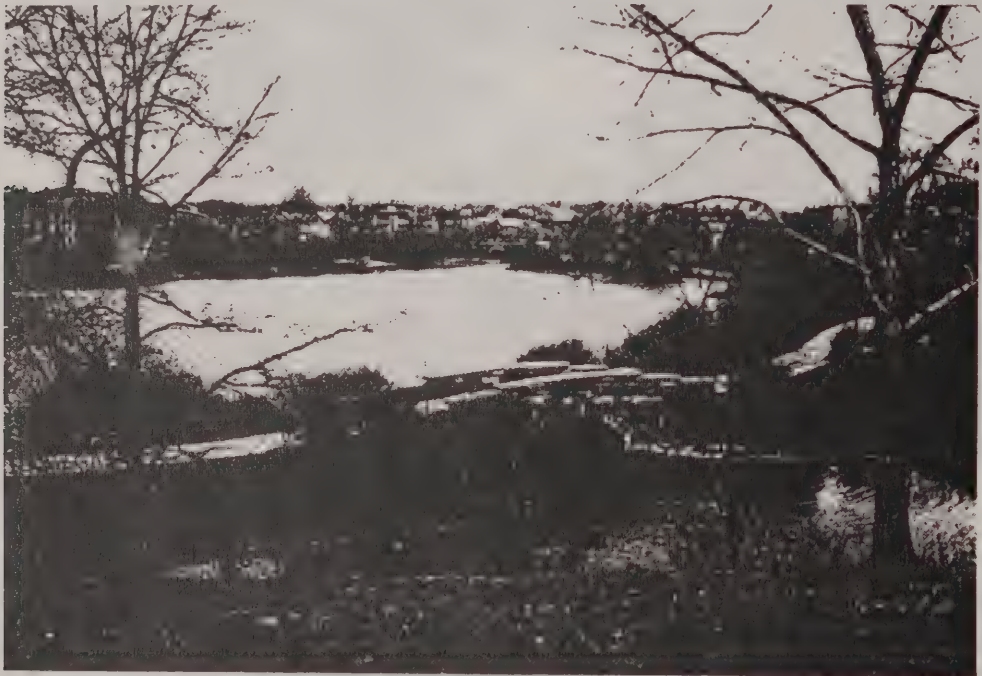


Figure 4-45
View of Leverett Pond Cove Bridge, c.1900
Source: Frances Loeb Library HASD

There is no Secondary Period of Significance since there has been no major designer involved in Olmsted Park since Frederick Law Olmsted's involvement. In 1897 John A. Pettigrew was hired as Park Superintendent for the Boston side. T he contract with the Olmsted Firm was not renewed. In 1898 the first dredging in Leverett Pond at the mouth of the Village Brook storm sewer occurred.

In the 1940's the Boston Park Department placed a baseball diamond in the meadow east of Leverett Pond. Today this meadow is called Daisy Field. A second baseball diamond followed, as did associated lighting. In 1956 the Metropolitan District Commission assumed care and control of the Jamaicaway, Perkins Street, Chestnut Stre[illegible]d Willow Pond Road as well as a twenty-five (25') foot taking of a right of way into the parkland [illegible]d Avenue, which is dated to the 1881 survey, is the only road surrounding the park that is not unc[illegible]DC control.

In 1971 Olmsted Park was placed on the National Register of Historic Places under the National Preservation Act of 1966, along with all of Olmsted's Emerald Necklace Parks and Parkways. In

October 24, 1989 Olmsted Park was designated a landmark by the City of Boston under Chapter 772 of the Acts of 1975.

Projects completed in Olmsted Park since the adoption of the Emerald Necklace Master Plan are documented in the Master Plan contained in Appendix A

The list of Historic Plans and Plant Lists for the Leverett Pond area is contained in the Appendix C.

4.5.3.2 Land Use

The land use on both sides of Leverett Pond is residential, with two exceptions on the eastern side of the Jamaicaway. At the northern corner of Leverett Pond, there is commercial land use with a gas station to the east of the Jamaicaway. Further south, there is institutional land use with Sherrill House and The Home for Little Wanderers, after which the land use again becomes residential.

4.5.3.3 Active Recreation

Olmsted designed the park as a scenic picturesque park, with activities that were compatible with enjoying the scenery. The pedestrian circulation system around Leverett Pond is extant, except fir the portion of the footpath on the Boston side at the southern end. The equestrian path along the Jamaicaway has been coverted into a bikeway, but its location is extant. On the Brookline side Riverdale Parkway has been converted into a bikeway and limited parking has been added in a structured parking lot on the southern end to accommodate park users, but the footpath is extant from the Olmsted period. Canoeing activities no longer functional. The current footpaths and bikeways are used for walking, biking, and running. There are also beaches for sitting and viewing.

The active recreation in the Leverett Pond area consists of two, lighted baseball diamonds in Daisy Field in Boston. A structured parking lot at Willow Pond Road accommodates park users of the athletic fields.

4.5.3.4 Pedestrian Access

Pedestrian conditions immediately surrounding the Leverett Pond were examined. Land uses surrounding the Leverett Pond are predominantly residential. Pedestrian demands were collected adjacent to the Leverett Pond in July 2000 from 8:00 AM to 6:00 PM on a weekday when the weather was amenable to pedestrian activity (i.e. warm temperature, no rain). Weekday counts at this time were chosen to be consistent with typical periods of activity for a construction project. Daisy Field was not in use at the time of these counts. Figure 4-46 presents the pedestrian volumes that were observed near Leverett Pond.

The pedestrian demands in this area are relatively low. On the path on the east side of Willow Pond, here were, at most, 40 pedestrians per hour. This occurred in the evening peak hour around 4:00 PM. On the path on the west side of Leverett Pond, there were about 50 pedestrians per hour, again occurring during the evening peak hour around 4:00 PM. Pedestrian volumes in this segment are much lower than along the Riverway segment to the north.

The existing paths and sidewalks adjacent to Leverett Pond are in good condition. There are no notable pedestrian issues that were observed in this area. This area is served adequately by public transit.

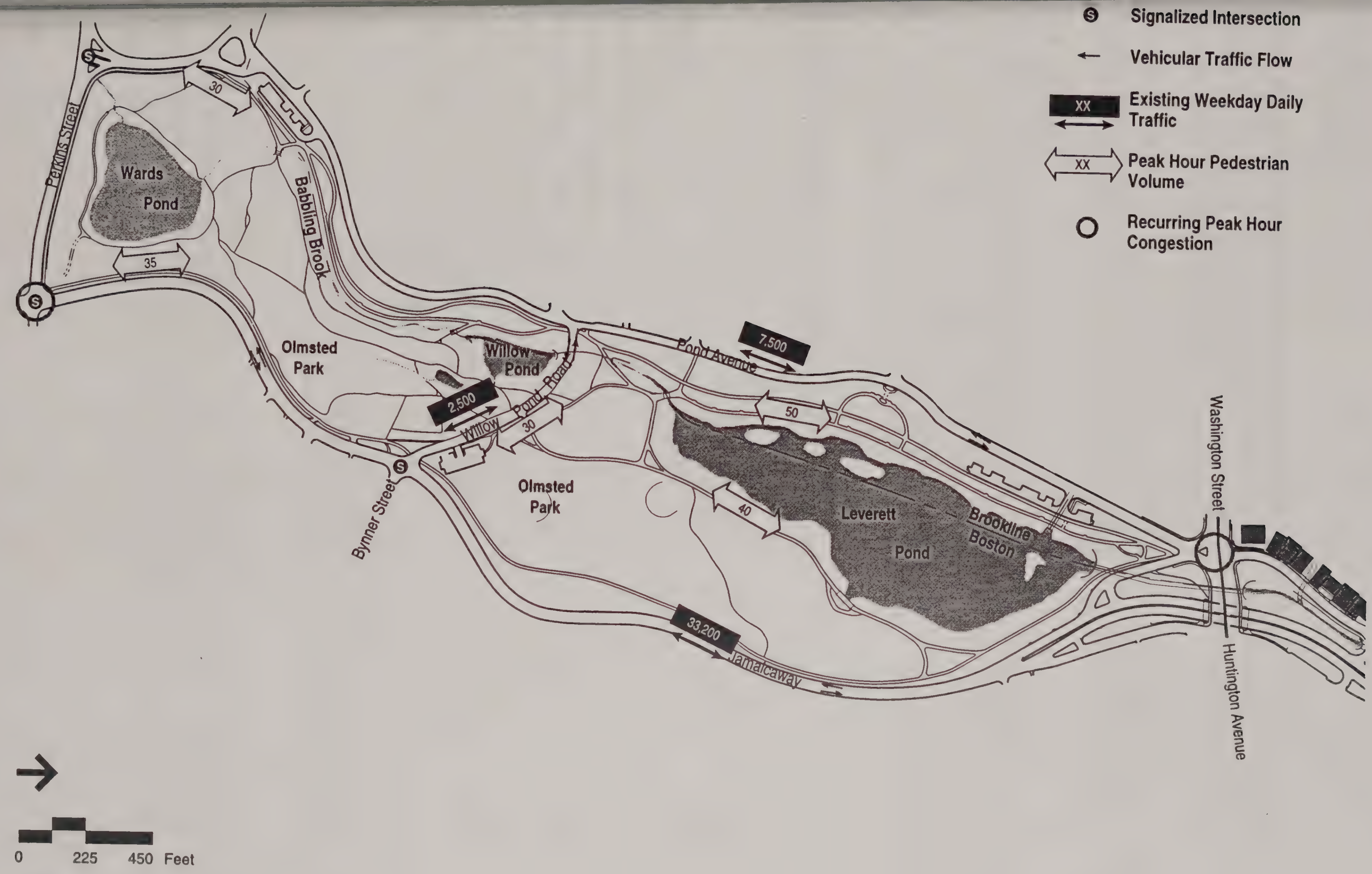


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Figure 4-46
Muddy River Restoration
Leverett Pond/Willow Pond/Wards Pond
Area Existing Traffic Conditions
Source: VHB, Inc.

There are nearby Green Line subway stations on South Huntington Avenue (E- Line Riverway, Back of the Hill, Heath Street Stations,) and on Huntington Avenue/ Boylston Street (D Line, Brookline Village Station near Harvard Avenue,). The MBTA bus routes 39, 60, and 66 serve the area along Huntington Avenue, South Huntington Avenue and High Street.

Counts of bicyclists in the area were conducted concurrently with the pedestrian counts. Observations indicate less than 10 bicyclists during the peak hour of the day in the Leverett Pond area. The vehicular travel lanes on the Jamaicaway are narrow, so all bicyclists were observed using sidewalks or paths.

4.5.4 Traffic

The discussion of traffic conditions in the Leverett Pond area of the project focuses on the Jamaicaway and Pond Avenue corridors from Huntington Avenue to Willow Pond Road. The Jamaicaway is a four-lane roadway that experiences recurring peak hour congestion. The Jamaicaway is an MDC roadway that is restricted to passenger vehicles only. Traffic demands on Pond Avenue are relatively low compared to the Jamaicaway. Table 4-20 provides a summary of the demands on the Jamaicaway. They are also depicted on Figure 4-46.

Table 4-20
Traffic Volume Summary - The Leverett Pond Area

Roadway	Morning Peak Hour Volume (vph)[1]	Evening Peak Hour Volume (vph)	Weekday Daily Volume (vpd)[2]
Jamaicaway - northbound, north of Willow Pond Road	2,100	1,370	17,100
Jamaicaway - southbound, north of Willow Pond Road	840	1,860	16,100
Pond Avenue - just north of Willow Pond Road (both directions)	535	870	7,500
Willow Pond Road - at the Jamaicaway	155	240	2,500

Source: Traffic counts conducted by VHB in July 2000.
[1] Peak hour volume expressed in vehicles per hour (vph).
[2] Daily volume expressed in vehicles per day (vpd).

The Jamaicaway carries 33,200 vehicles daily (northbound and southbound). Morning peak hour volumes are 2,940 vph and are predominantly headed to the north. In the evening peak hour, traffic demands are 3,230 vph and are predominantly to the south. Pond Avenue carries approximately 7,500 vehicles daily.

Using the traffic data that were collected, the weekday peak hours periods through the Leverett Pond Area were estimated. The morning peak hours occurs between 7:30 AM and 8:30 AM and the evening peak hours occur between 5:00 PM and 6:00 PM. These intervals are based on hourly traffic demand fluctuations along the Jamaicaway, north of Willow Pond Road, on a typical weekday (this portion of the Jamaicaway carries the heaviest traffic demands through this area).

There are notable traffic demands between the Jamaicaway and Huntington Avenue resulting in difficult merging and diverging movements between these roadways. There is also significant congestion on Huntington Avenue on either side of the Jamaicaway caused by turns and heavy demands at the closely spaced intersections of Huntington Avenue/Brookline Avenue and Huntington Avenue/South Huntington Avenue. The congestion on the Jamaicaway is more severe in the southbound direction than in the northbound direction due to the left-turns into minor streets and driveways.

The intersection of the Jamaicaway and Perkins Street (further to the south of Leverett Pond) is congested during peak hours with vehicle queues extending along the Jamaicaway past Willow Pond Road at times. Although there were no notable operational issues along Pond Avenue in this area, the southbound demands along Pond Avenue increase in the evening peak hour as a result of motorists from Huntington Avenue using Pond Avenue as a bypass of the Jamaicaway corridor.

4.6 Willow Pond

4.6.1 Physical Environmental Features

Steep slopes surround Willow Pond on its east, south and west sides (see Figure 4-47). Olmsted created Willow Pond by constructing a dam at the northern end and removing sediments. The resulting pond was 8 feet deep and 1 acres in size and contained a small island of 650 square feet. Since its origination, Willow Pond was dredged once in 1963 to a depth of 7.5 feet from the then existing two-foot depth. Willow Pond is now filled with sediment and the resulting sandbars are visible above the water surface.

The outlet work on Willow Pond is unique. As shown in Figure 4-48, the outlet works are made of brick/masonry construction with the spillway consisting of three arches. Water flowing over the spillway falls into a flume which then enters a brick/masonry conduit. This conduit generally is under the grass and enters the inlet to Leverett pond a short distance above the first foot bridge. A "dry weather outlet" is located below the spillway but above a blow-off valve. The dry weather outlet is believed to end at the head of the dry portion of the "babbling brook" below Willow Pond Road. Apparently it was intended to maintain flow into Leverett Pond even when there was insufficient water to flow over the spillway. The blow-off valve could be used to empty the pond.

Since its origination, Willow Pond dredged only once in 1963 to a depth of 7.5 feet from the then existing 2-foot depth. Presently, Willow Pond is filled with sediment. Resultant vegetated sandbars are visible above the water surface.

4.6.1.1 Hydrology

Willow Pond receives stormwater contributions from the Chestnut Street Drain, from upstream discharge from Wards Pond. The elevation of the spillway at Willow Pond is about 15.37 ft BCB, much higher than the bed elevation of the Riverway, which is between 4 and 5 ft BCB.

The pond experienced an impact from downstream flooding in the Riverway during the October 1996 storm. Although Willow Pond and Wards Pond are not simulated explicitly in the hydraulic model, the water level in the Riverway during the October 1996 storm is shown to be about 19 ft BCB.

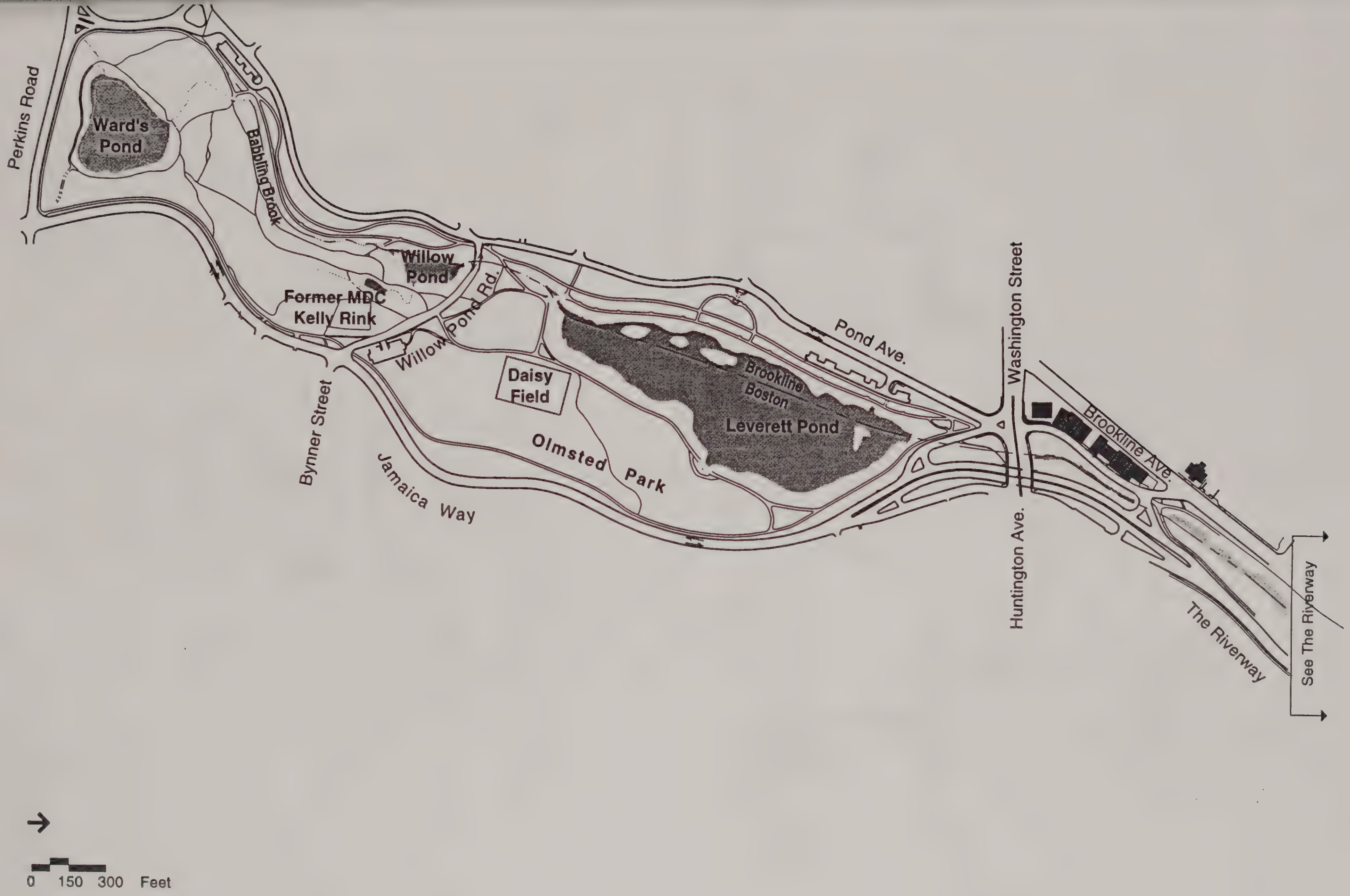
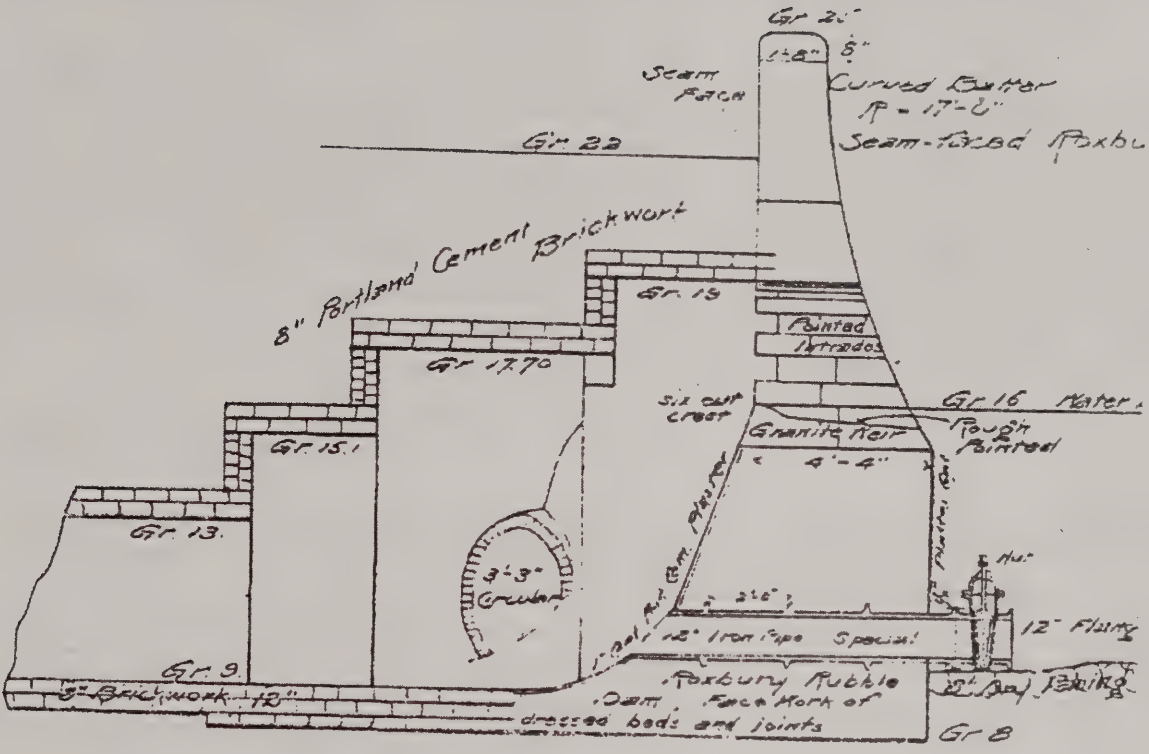
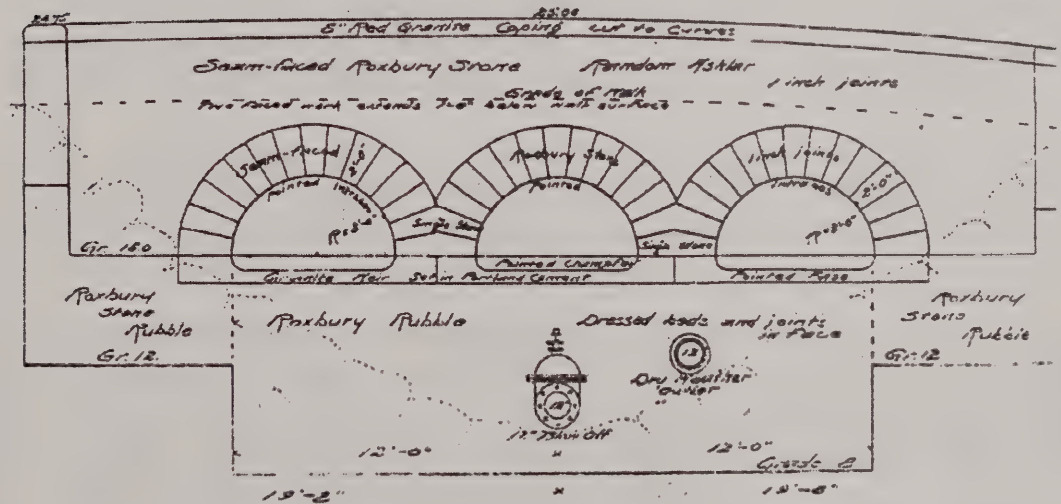


Figure 4-47
Olmsted Park
Source: VHB, Inc.



Longitudinal Section on Axis Line



End Elevation developed on outer line of Coping

Figure 4-48
Willow Pond Outlet
Source: A. H. French Engineers

Assuming a backwater effect up to Willow Pond under the existing conditions, this elevation of 19 ft would cause some minor flooding in Willow Pond.

4.6.1.2 Sediment Quality

Five borings were advanced in Willow Pond. However, due to the soft sediment only two of the locations could be advanced by drill rig. At the remaining locations, only surficial sediment samples were collected. The following geologic description therefore is based on observations recorded at WL-SED-1 and WL-SED-5. These borings were completed to a maximum depth of twelve feet below the top of sediment or until native material was encountered. The general stratigraphy consisted of varying thickness (0 to 8 ft) of a soft, black, organic silt layer, intermixed with fine to coarse sand and gravel. The native material underlying the silt layer typically was observed at two to eight feet below the top of the sediment. The native material consists of tan, medium dense sand and silt. Petroleum odors were observed during the installation of boring WL-SED-5 in samples from the top of the sediment layer to a depth of eight feet.

The analytical results for the VPH scan showed detectable levels of C_5 to C_8 and C_9 to C_{12} aliphatic hydrocarbons in samples of fill and native material collected at locations WL-SED-1 and WL-SED-5. At locations WL-SED-2, -3 and -4, samples were only collected from the 0 to 2 ft depth interval. The results of these samples showed elevated levels of the C_9 to C_{10} aromatic hydrocarbons and the C_9 to C_{12} aliphatic hydrocarbons. The total carbon range concentrations were 118 mg/kg in sample WL-SED-02, 51 mg/kg in sample WL-SED-3 and 69 mg/kg in sample WL-SED-4. Individual target compounds were not detected in any of the samples analyzed.

Based on the VPH results of samples collected from locations WL-SED-1 and WL-SED-5, that noted that non-fuel hydrocarbons were contributing to the C_5 to C_8 aliphatic range, samples collected from WL-SED-2, -3 and -4 were also analyzed for VOCs by Method 8260. The VOC compounds detected in sample WL-SED-2 include meta, para-xylenes at 0.12 mg/kg, meta-propylbenzene at 0.11 mg/kg, 1,3,5-trimethylbenzene at 0.25 mg/kg, 1,2,4-trimethylbenzene at 0.53 mg/kg and sec-butylbenzene at 0.13 mg/kg. The compounds detected in sample WL-SED-3 include toluene at 0.18 mg/kg and 1,2,4-trimethlybenzene at 0.13 mg/kg. There were no VOCs detected in sample WL-SED-4.

The results of the EPH scan were well below the DEP landfill reuse levels in each of the samples analyzed. The total PAH compounds in samples WL-SED-2 and WL-SED-3 were above the 100 mg/kg limit at concentrations of 101 mg/kg and 213 mg/kg, respectively. The results for PAHs in samples WL-SED-1, -4 and –5 were well below the 100 mg/kg limit.

The results of the PCB analysis showed concentrations well below the 2 mg/kg limit. The results of the pesticide analysis showed detectable levels of 4,4'-DDD, 4,4'-DDE and 4,4'-DDT. Concentrations of 4,4'-DDD above 1 mg/kg were found at each of the sample locations. The highest concentration of 3.8 mg/kg was found in the sample collected at WL-SED-3. The highest concentration for 4,4'-DDT of 3.6 mg/kg was found in the native sample collected from WL-SED-5.

The concentrations of metals found were below the DEP landfill reuse levels, and were generally lower in comparison with the other study areas. None of the samples tested for TCLP lead exceeded the regulatory limit. The results for reactive cyanide and sulfide were below their respective regulatory limits. One sample was tested for the paint filter test. The results showed that there was no free liquid present. The results for Willow Pond are summarized in Table 4-21.

Table 4-21
Summary of Sediment Analytical Results - Willow Pond

Contaminant	No. of Samples	Concentration [1] Minimum	Maximum	DEP Landfill Reuse Levels [1] Unlined	Lined	No. of Samples Exceedi Unlined	Lined
Total Arsenic	10	ND	36	40	40	No Exceedances	
Total Cadmium	10	ND	2.3	30	80	No Exceedances	
Total Chromium	10	9.2	57	1000	1000	No Exceedances	
Total Lead	10	4	960	1000	2000	No Exceedances	
TCLP Lead (mg/L)	4	ND	2	NA	NA	No Exceedances	
Total Mercury	10	ND	0.8	10	10	No Exceedances	
Total EPH	10	ND	1410	2500	5000	No Exceedances	
Total PCBs	9	ND	0.153	<2	<2	No Exceedances	
Total PAHs	10	ND	213	100	100	2	2
Total VPH	10	6	118	NA	NA	No Exceedances	
Total VPH Target	10	Not Detected		4	10	No Exceedances	
Reactive Sulfide	9	ND	270	500		No Exceedances	
Reactive Cyanide	9	Not Detected		250		No Exceedances	
pH	9	5.7	7	2 < pH < 12.5		No Exceedances	
Conductivity	9	80	500	4000 umhos/cm	8000 umhos/cm	No Exceedances	

[1] All results are reported in mg/kg unless otherwise noted.

The methodology for the sediment test program, analytical results, and summary figures are included in Appendix F.

Elutriate analyses were conducted on sediment from Willow Pond in order to determine, if during the process of hydraulic dredging, if any toxic metals could be released to the environment. The metals that were analyzed included those that are required by the ACOE and the MA DEP, i.e. antimony, arsenic, beryllium, cadmium chromium, copper, lead, mercury, nickel, selenium, silver, thallium, zinc. In the elutriate analysis procedure, sediment is mixed with water at the same general ratio as would occur during hydraulic dredging, i.e. 1 part of sediment to 5 parts of water. The sediment and water are mixed, filtered, and tested. The receiving water is also tested for the same constituents. The difference in concentrations indicate the magnitude of the toxins that could be released during the dredging. The sample location(s) that were selected were done so because the results of the bulk sediment characterization indicated high levels of contamination. An elutriate analysis was conducted on sediment that was collected from Willow Pond at station WL Sed 3) that is shown on Figure F2-5A in Appendix F. The tests on sediment sample WL Sed 3 resulted in the release of 0. 0.0[illegible] mg/l of arsenic. The concentration of arsenic that was released is below the acute and chronic freshwater water quality criteria of 0.360 mg/l and 0.190 mg/l, respectively.

4.6.1.3 Water Quality

Willow Pond receives water from Wards Pond via the "Babbling Brook", from Spring Pond, from groundwater discharge, and from the Chestnut Street Drain. The Chestnut Street Drain encompasses 179 acres of a residential and steeply sloped watershed.

The Massachusetts Department of Environmental Protection (DEP) has established Water Quality Standards for all waters in the Commonwealth. The Muddy River watershed has been classified as Class B waters. As such, Class B water are considered swimmable and fishable.

In order to assess the water quality of Willow Pond, a review of the water quality history was conducted and water also was sampled and analyzed as part of this project. The historical water quality data includes that from:

Division of Water Pollution Control (now the MA DEP)	1986
Army Corps of Engineers	1992
Northeastern University	1995
Charles River Watershed Association (CRWA)	1998

The historical data indicated that water quality standards for bacteria(<200 fecal coliform per 100 ml of water), temperature(<20°C), dissolved oxygen(>5 mg/1 and >75 % of saturation), and pH(6.5-8.3 units) were met in 1986, 1992, 1998 (temperature, dissolved oxygen and pH were not tested by the CRWA). While testing diurnal oxygen dynamics in the Muddy River, Northeastern University discovered that the dissolved oxygen was below the Class B water quality criteria.

While the Water Quality Standards do not have numeric criteria for suspended solids, nitrogen and phosphorus, certain limnological (the study of freshwater ecology) water quality values were applied to the Muddy River because of its lotic (slow moving) character. These were 20 milligrams per liter (mg/l) for total suspended solids (TSS), 0.30 mg/l for inorganic nitrogen (the summation of nitrate, nitrite, and ammonia nitrogen forms), and 0.01 mg/l for total phosphorus. Applying these values against the historical data, it was noted that excessive nutrient conditions in Willow Pond have occurred.

On October 4 (dry weather conditions), October 6 (wet weather conditions) and December 14 (wet weather conditions) the water quality of Willow Pond at its outlet and the discharge of the Chestnut Street Drain m were sampled and analyzed for the following parameters:

Temperature
Dissolved Oxygen (DO)
pH
Turbidity
Total Suspended Solids (TSS)
True and Apparent Color
Nitrate plus Nitrite Nitrogen
Ammonia Nitrogen
Total Phosphorus
Fecal Coliform Bacteria
Fecal Streptococcus Bacteria

The results of the analysis are as follows.

Water Quality Parameter	Dry Weather	Wet Weather
Temperature	P/P/P	NS/P/P
Dissolved Oxygen (DO)	P/P/P	NS/P/P
pH	P/P/P	NS/P/P
Total Suspended Solids	P/F/P	NS/P/F
Inorganic Nitrogen	P/F/F	NS/F/F
Total Phosphorus	F/F/F	NS/F/F
Fecal Coliform Bacteria	P/F/F	NS/F/F

NS-Not Sampled
P-Pass
F-Fail
P/F/F- Pass dry weather (October 4)/ Fail wet weather (October 14)/ Fail wet weather (December 14, 2000)

The water quality report is contained in Appendix G.

The dissolved oxygen concentrations were high during dry and wet weather and were present above 90 percent of saturation. As shown by the alkalinity value, the water in Willow Pond has some buffering capacity against downward changes in pH. A higher alkalinity value was found during wet weather, possibly due to the influence of the Chestnut Street Drain which enters Willow Pond adjacent to the inlet from Wards Pond. The water in Willow Pond was found to contain a circum-neutral pH during dry weather and a more alkaline pH during wet weather. There is some indication of humic materials being present in the water, based on the finding that more than one half of the color value is true color. For comparison, tea contains nearly all-true color because the tea is dissolved into the brew. While the suspended solids were low during dry weather, they were very high during wet weather. Although similar suspended solids values were not found in the discharge from the Chestnut Street Drain during wet weather, the high solids in Willow Pond suggests that the bottom mud was mixed during the rain storm. Inorganic nitrogen during dry weather was acceptable while it more than tripled during wet weather. The wet weather phosphorus concentration was almost fifteen times that of the dry weather sample. The fecal coliform concentration during dry weather was low. However, the wet weather concentration was almost an order of magnitude higher. The ratio between the fecal coliform and fecal streptococcus bacteria is inconclusive as to suggesting animal waste as a potential source of bacteria.

Chestnut Street Drain discharges to Willow Pond during wet weather contained a circum-neutral pH. The turbidity and color values were higher than the corresponding values in Willow Pond. However, the wet weather flow in the drain contained a low level of suspended solids, possibly because the first flush had passed before the sampling was conducted. The nutrient values are still considered high. The water quality standard for fecal coliform bacteria was exceeded in the Chestnut Street area. In keeping with EPA guidance, the Massachusetts Department of Environmental Protection is developing guidelines for nutrient limitations where the technology based point and non-point source pollution controls are not stringent enough to meet the water quality standards. These guidelines are planned to be issued in 2003.

4.6.2 Biological Environment

The following information on the biological environment includes the existing woodlands, horticultural resources and aquatic and wildlife resources and wetlands.

4.6.2.1 Upland Vegetation and Horticultural Resources

The inventory, documentation and analysis of vegetation in the Willow Pond area were completed in August of 2000. The area includes the watercourse from Willow Pond Road to the pedestrian bridge at Wards Pond. The scope of work includes trees, shrubs, vines, and lawn areas including notation of areas of bare lawn and areas of erosion.

Vegetation breakdown under trees includes:
Deciduous trees - indicating species, caliper and condition
Evergreen trees - indicating species, caliper and condition
Woodland

Vegetation breakdown under shrubs includes:
Restored planting with five years of restoration
Shrub massings
Invasive plant colony - indicating species

Erosion includes:
Bare lawn
Wash outs of storm sewers
Desire lines
Overuse compaction
Surface roots of trees

Analysis of Existing Vegetation is contained in Table 4-22.

Table 4-22
Inventory and Analysis of Existing Vegetation - Willow Pond

Category	Unit	Total	Good	Fair	Poor	Dead
Trees:						
Canopy tree	each	119	27	79	10	3
Flowering tree	each	7	1	5	0	1
Evergreen tree	each	1	0	1	0	0
Heritage tree[1]	each	3	0	1	2	0
Total Trees:		**130**	**28**	**86**	**12**	**4**
Shrubs:	(Estimated)					
Restored planting	square footage	1,369				
Shrub massing	square footage	13,764				
Total Shrubs:		**15,133**				
Invasive Plant Colonies:	(Estimated)					
Phragmites	square footage	0				
Other Invasives (e.g. Knotwe	(Estimated)	29,336				
Total Invasive Plant Colonies:		**29,336**				
Woodland:	(Estimated)					
	square footage	**223,385**				

[1]Note: A heritage tree is a canopy tree with a 32" or greater caliper. If it is listed as a heritage tree, it will not be listed as a canopy tree.

In accordance with the Commonwealth of Massachusetts Department of Environmental Management standards, trees that are 32" inches in caliper and over are considered to be heritage trees. All trees have their species and caliper size identified and the condition of the heritage trees is rated as good, fai or poor as are all other trees on the site. The diameter of the circle for tree canopy is in relation to its caliper size.

Plan documentation is contained in the Appendices in the form of annotated Existing Conditions Plans.

4.6.2.2 Aquatic and Wildlife Resources

Not withstanding the present condition of Willow Pond, the aquatic and wildlife resources that are present around Willow Pond are diverse in nature, reflecting the diversity and good quality of the surrounding terrestrial and aquatic habitat. These areas include the adjacent woodlands, the inlet stream from Wards Pond, and the only remaining Olmsted natural history pool, known as Spring Pond.

Willow Pond is fed by water from Wards Pond, the adjacent Spring Pond, and groundwater seepage. The water in Willow Pond is warm due to the water temperature of Wards Pond as well as from natural heating and its inherent shallow depth. On the contrary, Spring Pond is well shaded and quite cool and clear year-round, as it is almost totally fed by groundwater discharge. The water in Willow

Pond is generally more turbid as a result of algae growth and suspended sediments. A Wildlife Habitat Evaluation and Vegetation Assessment of Willow Pond is contained in Appendix D.

Benthic Aquatic Resources

Aquatic benthic resources consist of those organisms, which through part or all of their life cycles, inhabit the bottom of the resource area. Due to the benthos' long-term contact with the bottom sediments and water, the benthic community typically reflects the chemical quality of the sediments and water. The benthic organisms range from those that are pollution intolerant, which inhabit only the cleanest of bottom deposits, to pollution tolerant species, which can inhabit contaminated sediments. The benthic community may consist of various fly larvae (e.g. true flies, caddisflies, may flies, stoneflies, dragonflies, etc.), worms, leeches, snails and other species. The benthic community serves as a food source for such bottom feeding fish as the carp, suckers and goldfish, as well as smaller forage fish species. Ducks and geese also feed upon these organisms.

The sediment in Willow Pond (see Section 4.6.1.2 – Sediment Quality) was found to contain high concentrations of petroleum hydrocarbons, polynuclear aromatic hydrocarbons and heavy metals, particularly lead (see Appendix F). Some Willow Pond sediments were found to contain leachable lead above regulatory criteria and are, therefore, considered toxic and hazardous. The following description of the benthic community in and around Willow Pond is based on field observations as well as professional judgement given the results of the chemical analyses. The following list contains the observed as well as species that are expected to inhabit Willow Pond.

Arthropods
- Insects
  - Chironomids (fly larvae)
  - Gerris (water strider)
  - Northern bluet (found in Spring Pond)

Crustaceans
- Amphipods
- Isopods

Annelids
- Oligochaete Worms
- Leeches

Molluscs
- Physa snails and other gastropod species

Black fly larvae, which are indicators of continually running cool water, were found inhabiting the surface of rocks located on the dam structure between Spring Pond and Willow Pond. In addition to these species, caddis fly larvae, which as a group are facultative to intolerant of pollution, have been observed in riffles in the "babbling brook" between Wards Pond and Willow Pond.

Aquatic vegetation observed in Willow Pond includes fanwort (*Cabomba caroliniana*), water cress (*Nasturtium officinale*), water starwort (*Callitricha verna*), duckweed (*Lemna minor*), water meal (*Wolffia*), and filamentous algae.

Fish Resources

Information on fish resources in Willow Pond was determined through sampling that was conducted as part of the Wildlife Habitat Evaluation and Vegetation Assessment (see Appendix D). Other data sources were not found. The three-spine stickleback, *Gasterosteous aculeatus*, was found in Spring Pond, and in the small pool immediately below the dam that separates from Spring into Willow Pond.

Wildlife Resources

The wildlife resources of Willow Pond include avian and non-avian species that were observed during the Wildlife Habitat Evaluation and Vegetation Assessment, which was conducted for this project (see Appendix D). Wildlife species that were observed at and around Willow Pond include the following:

Mammals

Eastern chipmunk	*Tamias striatus*
Eastern cottontail	*Sylvilagus floridanus*
Eastern gray squirrel	*Sciurus carolinensis*

Birds

American Crow	*Corvus brachyrhynchos*
American Robin	*Turdus migratorius*
Blue Jay	*Cyanocitta cristata*
European Starling	*Sturnus vulgaris*
Gray Catbird	*Dumetella carolinensis*
House Sparrow	*Passer domesticus*
Northern Cardinal	*Cardinalis cardinalis*

Amphibians

Green frogs	*Rana clamitans*
Bullfrogs	*Rana catesbeiana*

4.6.2.3 Rare Species

The Massachusetts Natural Heritage Program was consulted (see Appendix K) and while Endangered, Threatened Rare species are not reported to inhabit Willow Pond itself, the three-spine stickleback – [*Gasterosteus aculeatus*] (see Figure 4-49) was reported to be present in the only remaining Olmsted natural history pool (Spring Pond). The presence of the three-spine stickleback was confirmed through use of the electro-shocking sampling technique. The three-spine stickleback also was found to inhabit a small pool in Willow Pond that is immediately below the dam that separates Spring Pond from Willow Pond.

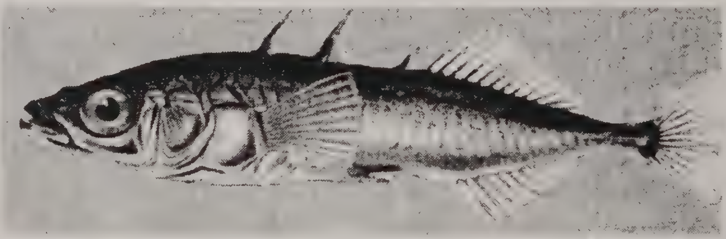


Figure 4-49
Three-Spine Stickleback

4.6.2.4 Wetland Resources

The wetland resources at Willow Pond were delineated during the Spring and Summer of 2000. An Abbreviated Notice of Resource Area Delineation (ANRAD), which contained the wetland delineation plans, was presented to the Boston and Brookline Conservation Commissions and accepted by both Commissions in September 2000. A description of the methodology that was used to delineate the wetlands around Willow Pond is provided in Appendix B.

The wetland delineation at Willow Pond resulted in the following resource area findings:

Bank	800 lf
Land Under Water	28,632 sf
Vegetation growing in Land Under Water	0 sf
Bordering Vegetated Wetland	35,719 sf

The following wetland plants were found to inhabit Willow Pond, Spring Pond and the adjacent areas.

Willow Pond

multiflora rose	*Rosa multifora*
red-osier dogwood	*Cornus stolonifera*
northern arrowwood	*Viburnum regnium*
purple loosestrife	*Lythrum salicaria*

4.6.2.5 Ecological Functions and Values

An Ecological Functions and Values analysis was conducted by following the US Army Corps of Engineers Highway Methodology (Supplement, November 1995). The purpose of the Functions and Values analysis is to provide as non-biased an assessment of the habitat and wildlife as possible. The results of the functions and values analysis are given in Table 4-23.

More pedestrian activity is seen at the Willow Pond portion of the Emerald Necklace than elsewhere. Walking paths are worn and vegetation is impacted by passive activities. The Pond is bounded on the west by the Riverway and on the east by a stone dust path system.

Willow Pond is approximately one acre in size. The maximum depth of the pond is approximately ten feet. The pond is fed by water from Wards Pond via the Babbling Brook and Spring Pond which is one of the original history pools, the Chestnut Street Drain, and groundwater discharge. The outlet to Willow Pond (see Figure 4-48) includes a 48" conduit located under Willow Pond Road, which discharges into Leverett Pond. There are approximately 0.82 acres of wetlands around the pond. Wetland types consist of a small amount of emergent vegetation at the outfall of Babbling Brook and a fringe of scrub/shrub throughout. Principal wetland functions and values consist of fish and shellfish habitat, passive recreation, and endangered species habitat.

The majority of the pond's wetlands are classified as scrub/shrub. Shrubs in the area consist of red osier dogwood (*Cornus stolonifera*), sweet pepperbush (*Clethra alnifolia*), American bittersweet (*Celastrus scandens*), weeping willow (*Salix babylonica*), barberry (*Myrica pensylvanica*), and virginia rose (*Rosa virginiana*). A significant stand of emergent vegetation exists at the outfall from Babbling Brook. The emergent vegetation is confined to two small island areas comprised of broadleaf arrowhead (*Sagittaria latifolia*), pickerelweed (*Pontederia cordata)*, barnyard grass (*Enhinocloa crusgalli)*, jewelweed (*Impatiens capensis)*, purple loosesrife (*Lythrum salicaria)*, rushes and mannagrass (*glyceria candensisl)*. The western side of Willow Pond consists of manicured lawn with a shrub fringe, while the eastern side is forested.

The Chestnut Street Drain discharges storm water from the surrounding area (approximately 129 acres) into Willow Pond. The drain has deposited a significant amount of sediment in the pond resulting in the formation of sandbars. Silt-laden overland flow from the path systems around the pond also

Willow Pond - PRESENT

Wetland Function-Value Evaluation Form

Total area of wetland________Human made?____Is wetland part of a wildlife corridor? __________or a "habitat island"?

Adjacent land use____Recreation____________ Distance to nearest roadway or other development________________

Dominant wetland systems present Scrub Shrub/Emergent Contiguous underdeveloped buffer zone

present__No________

Is the wetland a separate hydraulic system?_No_________If not, where does the wetland lie in the drainage basin?______

How many tributaries contribute to the wetland?_1________Wildlife & vegetation diversity/abundance (see attached list)

Wetland I.D.
Latitude______Longitude________
Prepared by:________Date_______
Wetland Impact:
Type______________Area_______
Evaluation based on:
Office____________Field_____
Corps manual wetland delineation
completed? Yes______No_______

Function/Value	Occurrence Y	Occurrence N	Rationale (Reference #)*	Principal Function(s)/Value(s)	Comments
Groundwater Recharge/Discharge		X	8, 13		No evidence of groundwater recharge or discharge.
Floodflow Alteration		X	3, 4, 5, 12,		Wetland is not large enough to hold significant amounts of flood waters.
Fish and Shellfish Habitat	X		3, 4, 7, 8, 10, 12, 14, 17.	X	Fish are present in the pond.
Sediment/Toxicant Retention		X	1,2, 5,15		Wetlands are narrow add provide no sediment retention.
Nutrient Removal		X	2, 4, 6, 9		Wetlands are narrow add provide no nutrient retention.
Production Export		X	1, 2, 4, 6, 8, 12,		Wetlands contain little wildlife food value.
Sediment/Shoreline Stabilization	X		1, 3. 5, 9, 15,		Vegetation along the bank has provided stabilization in most areas.
Wildlife Habitat		X	2, 7, 8, 9, 14		Wetland is not buffered, and there is little habitat diversity in vegetation. Wetland does provide habitat to ducks.
Recreation			1, 4, 7, 10, 11, 12	X	Wetland is easily accessible, and has some potential to function as educational and recreational area.

Table 4-23
Wetland Function-Value Evaluation Form for Willow Pond

Function/Value	Occurrence		Rationale (Reference #)*	Principal Function(s)/Value(s)	Comments
	Y	N			
Educational Scientific Value		X	3, 8, 9, 10, 12, 13,		Wetland is easily accessible, and has some potential to function as educational and recreational area.
Uniqueness/Heritage		X	1, 3, 8, 9, 10, 14, 16		
Visual Quality/Aesthetics		X	2, 7		Direct view of wetland and open water exist from the roadway.
ES Endangered Species Habitat	X		1, 2	X	Endangered species have been found in a portion of this pond
Other					

*Refer to back up list of numbered considerations.

Notes:

The 13 functions and values that are considered by the Regulatory Division for any Section 404 wetland permit are listed below. The list includes eight functions and five values. Values are grouped together at the end of the list.

These are not necessarily the only wetland functions and values possible. Not are they so precisely defined as to be unalterable. However, they do represent the best working 'palette' of descriptors, which can be used to paint an objective representation of the wetland resources associated with a proposed project.

Groundwater Recharge/Discharge--This function considers the potential for a wetland to serve as a groundwater recharge and/or discharge area. Recharge should relate to the potential for the wetland to contribute water to an aquifer. Discharge should relate to the potential for the wetland to serve as an area where groundwater can be discharged to the surface.

Floodflow Alteration (Storage & Desynchronization)--This function considers the effectiveness of the wetland in reducing flood damage by attenuation of floodwaters for prolonged periods following precipitation events.

Fish and Shellfish Habitat--This function considers the effectiveness of seasonal or permanent waterbodies associated with the wetland in question for fish and shellfish habitat.

Sediment/Toxicant/Pathogen Retention--This function reduces or prevents degradation of water quality. It relates to the effectiveness of the wetland as a trap for sediments, toxicants or pathogens.

Nutrient Removal/Retention/Transformation--This function relates to the effectiveness of the wetland to prevent adverse effects of excess nutrients entering aquifers or surface waters such as ponds, lakes, streams, rivers, or estuaries.

Product Export (Nutrient)--This function relates to the effectiveness of the wetland to produce food or usable products for human, or other living organisms.

Sediment/Shoreline Stabilization--This function relates to the effectiveness of the wetland to stabilize stream banks and shorelines against erosion.

Wildlife Habitat--This function relates to the effectiveness of the wetland to provide habitat for various types and populations of animals typically associated with wetlands and the wetland edge. Both resident and/or migrating species must be considered. Species lists of observed and potential animals should be included in the wetland assessment report.

Recreation (Consumptive and Non-Consumptive)--This value considers the effectiveness of the wetland and associated watercourses to provide recreational opportunities such as canoeing, boating, fishing, hunting and other active or passive recreational activities. Consumptive opportunities consume or diminish the plants, animals, or other resources that are intrinsic to the wetland, whereas non-consumptive opportunities do not.

Education/Scientific Value--This value considers the effectiveness of the wetland as a site for an 'outdoor classroom' or as a location for scientific research or study.

★ **Uniqueness/Heritage**--This value considers the effectiveness of the wetland or its associated waterbodies to produce certain special values. Special values may include such things as archeological sites, unusual aesthetic quality, historical events, or unique plants, animals, or geological features.

👁 **Visual Quality/Aesthetics**--This value relates to the visual and aesthetic qualities of the wetland.

ES **Threatened or Endangered Species Habitat**---This value considers the effectiveness of the wetland or its associated waterbodies to support threatened or endangered species.
Source: ACOE

contributes to the siltation. It is evident that the water quality of Willow Pond is not as desirable as that of Wards Pond.

Due to the narrowness of the wetlands surrounding the pond, flood storage capacity and/or sediment retention is considerably hindered. Hydric soils are present in the wetland and are able to retain some flood water.

Animal species observed in Willow Pond include a variety of avian, insects, amphibians, and freshwater fishes. Fish present in Willow Pond are included in Appendix D. The diverse vegetative community supports a strong diversity of wildlife habitat. In addition, a state listed endangered species, the threespine stickleback (*Gasterosteus aculeatus Linnaeus*), was observed in a portion of Willow Pond adjacent to the outlet from Spring Pond.

4.6.3 Cultural Environment

4.6.3.1 Historic Resources

The Willow Pond Area has a Primary Period of Significance of 1880-1895, which is the Frederick Law Olmsted design for the area. In **1880** Olmsted completed a plan titled "Suggestion for the Improvement of Muddy River", which is published in the Sixth Annual Report of the Boston Park Commissioners and in the Annual Report of the Brookline Park Commissioners. The suggested improvement included a diagrammatic plan for the proposed park prior to the 1881 design plan. Frederick Law Olmsted set forth his intent:

> *"Upper Valley of Muddy River -- A chain of picturesque fresh-water ponds, alternating with attractive natural groves and meads.*
>
> *From Tremont Street, southwardly to Jamaica Pond, the waters widen out into pools and ponds, connected by a rapid brook, and, besides the scenery a more varied Parkway, the road on the Boston side has been named Jamaica-way, thus indirectly, by change of name, recognizing the change of landscape character. The public way on the Brookline side is named Brookline Road, the use of the word 'road' being appropriate to its rural character."*

A July 23, **1881** survey titled "Plan of Proposed Muddy River Improvement Showing Contours," prepared by Boston City Engineer Henry M. Wrightman, documents the site prior to the start of Olmsted's work. The Willow Pond site was a small pond with a small brook feeding it and a small brook out-letting to Leverett Pond (see Figure 4-50).

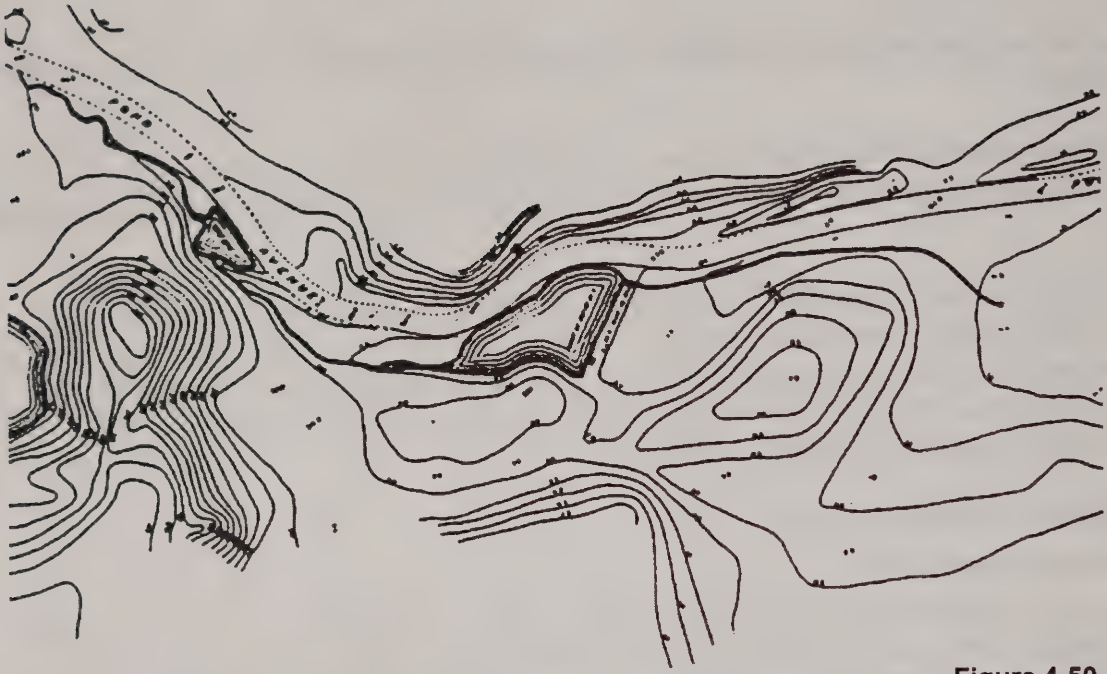


Figure 4-50
Plan of Proposed Muddy River Improvements Showing Contours 1881
Source: FLOHNS,

Several sources of information document the park during the Olmsted period including:

1) The **1881** "General Plan for The Sanitary Improvement of Muddy River and for Completing a Continuous Promenade between Boston Common and Jamaica Pond"; 2) the 1889 "Outline of Revised Plan for The Parkway and Sanitary Improvement of Muddy River showing the proposed change in the Town boundary and the relationship of the proposed pleasure ground to the neighboring streets and to the lately suggested revisions to the railroad arrangements between Chapel and Longwood Stations; 3) " The **1889** Revised plan for the upper part of the Muddy River (Olmsted Park), increases the site acreage to accommodate the natural history pools); 4) the **1890** plan published in the Fifteenth Annual Report of the Boston Park Commissioners and the Annual Report of the Brookline Park Commissioners; 5) The **1892** lithograph titled "Plan of the Parkway between Muddy River Gate House and Jamaica Park, and 6) the **1896** "Plan of Portion of Park System from Common to Franklin Park document the park during the Olmsted Period (see Figure 4-51).

In addition, a series of plans dating **1890 to 1893** provides detailed proposed grading, historic shoreline, plant massings with viewsheds, plant lists, and planting plans for the Olmsted design.

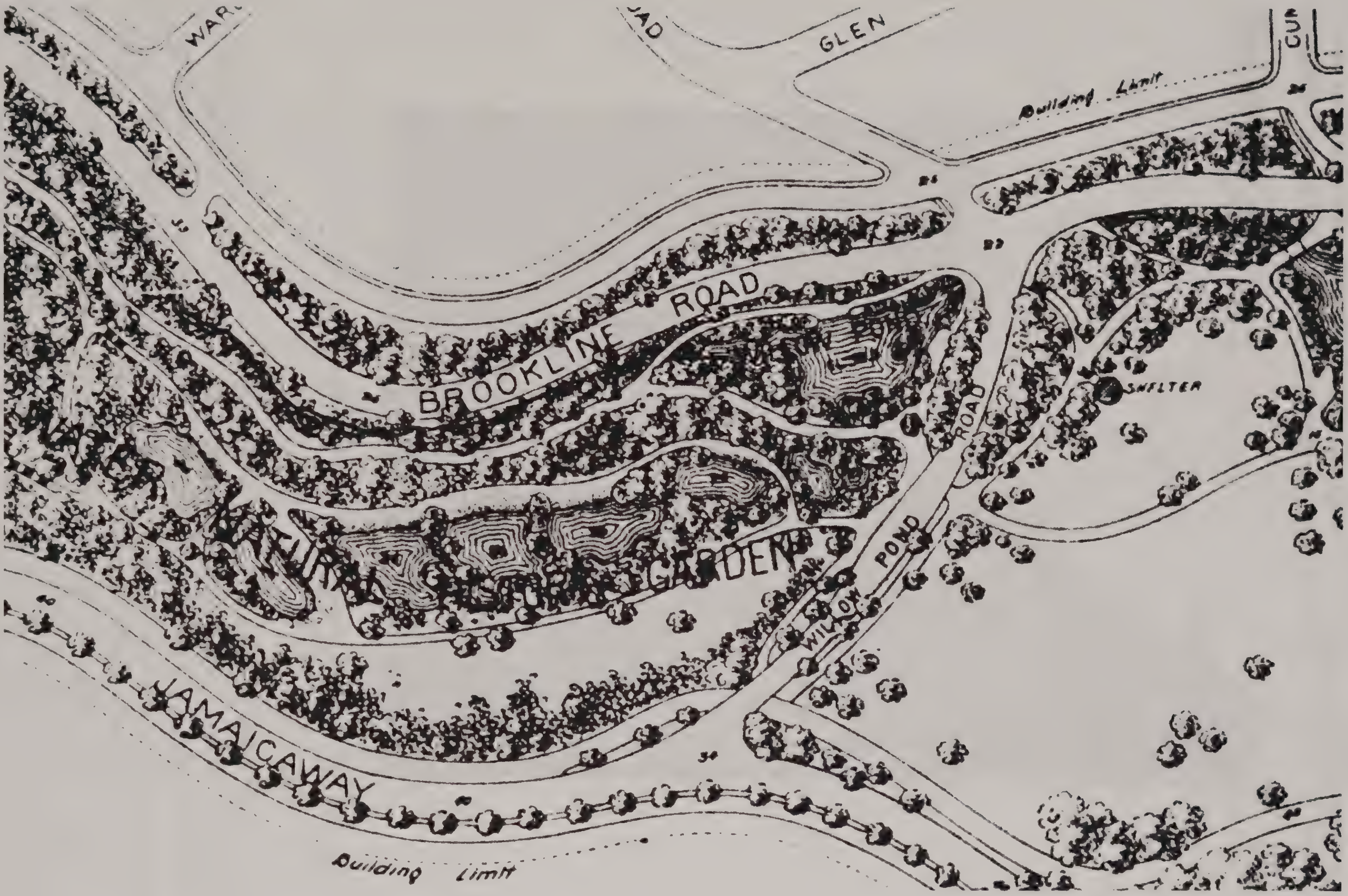


Figure 4-51
Plan of the Parkway Between the Muddy River Gatehouse and Jamaica Park, 1892
Source: FLONHS

There is limited photographic documentation for the pond. Photographs illustrate how the shoreline of the pond was constructed and the plantings and original bank treatments; be they planted or grass beaches coming down to the edge of emergent vegetation (see Figure 4-52).

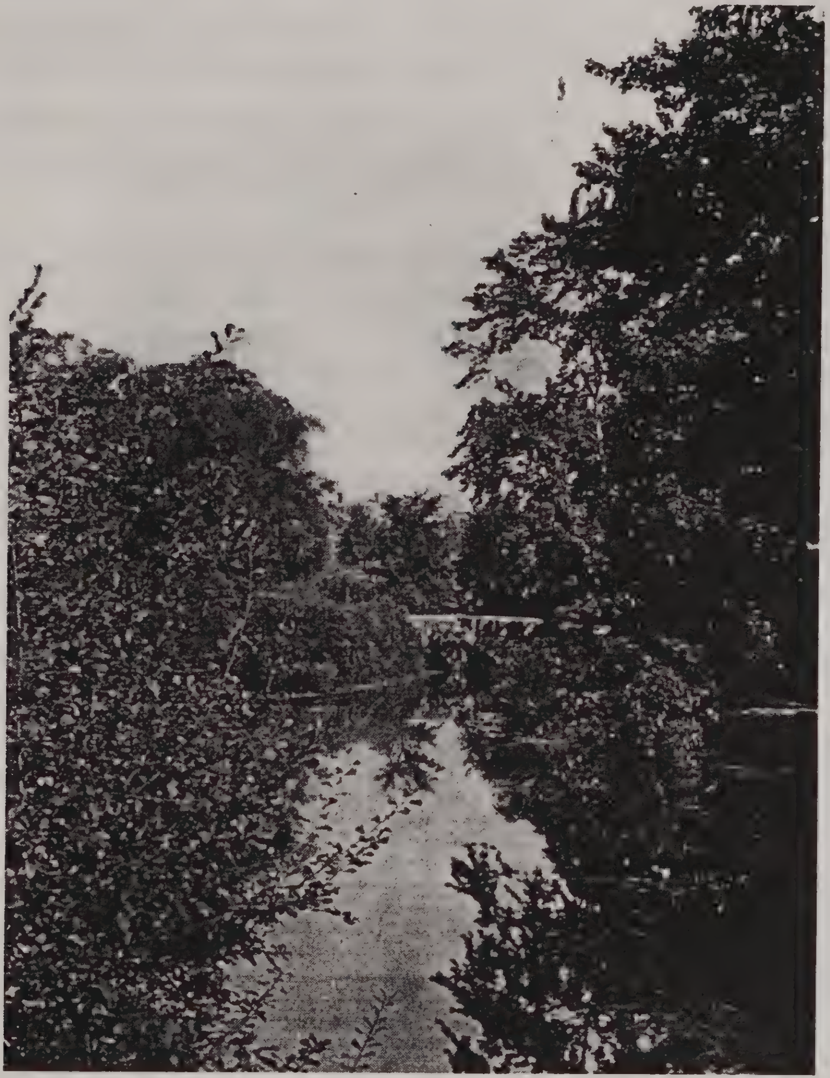


Figure 4-52
View of Willow Pond Toward Willow Pond Road Culvert Bridge, 1900
Source: FLONHS

We have complete grading plans that delineate the grading and shape of the shoreline as designed and constructed by Olmsted. We can overlaying the plans of the shoreline created during the Primary Period of Significance with surveys showing the existing conditions today, and so determine what area of shoreline are still extant from that period. We also have extensive drawings documenting the planting that was done in Olmsted's circulation system around Willow Pond as part of his transformation of the site to serve the purposes of a public park. The path systems and the separation of carriage and foot traffic were the major feature that allowed the passive user to view the picturesque pond landscape and the carriage drive or parkway to view its green edge, without causing physical danger or interfering with the experience of the landscape of each. Riverdale Parkway, west of Willow

Pond, was a designed and constructed by Olmsted as a park drive within the park, but it had become a commuter route with parked cars at its edge and was impacting the use of the park. The 1990 Master Plan discontinued the parkway converting it into a pedestrian and bicycle path, which was completed between 1998-2000.

A granite footbridge was built at the southern end of the pond to cross over the Babbling Brook feeding into the pond. Willow Pond Bridge, a bridge/culvert, was constructed at the north edge as the water left the pond. Both bridges provided viewing points or were features set in Olmsted's picturesque views. Two small stone culvert bridges were constructed in the history pool area and a bridge/culvert and waterfall entered the east side of Willow Pond below the history pools.

There is no Secondary Period of Significance since there has been no major designer involved in Olmsted Park since Frederick Law Olmsted's involvement. In **1897** John A. Pettigrew was hired, as Park Superintendent for the Boston side and the contract with the Olmsted Firm was not renewed. A decision was made under Pettigrew to fill two of the Natural History pools at Spring Pond above Willow Pond (**1898**), since the Society could not raise funds. Pettigrew also began "rearranging" the plantations, adding broadleaf evergreens.

In **1956** the Metropolitan District Commission took care and control of the Jamaicaway, Perkins Street, Chestnut Street and Willow Pond Road as well as a twenty-five (25') foot taking of a right of way into the parkland. Pond Avenue, which dates to the 1881 survey, is the only road surrounding the park tha is not under MDC control.

State legislation in 1962 and 1963 directed the MDC to take by eminent domain or otherwise, land in Jamaica Plain and elsewhere for skating rinks. In **1964** the City of Boston conveyed to the MDC a parcel of land east of Willow Pond to construct a skating rink. By 1965 the Sergeant Peter Kelly Rink was constructed. In 1997 the rink was removed.

Further takings as well as modifications to the parkway and road systems were planned by the MDC starting in 1967, when a one-way system of parkways was recommended around Olmsted Park and Jamaica Pond. This involved a taking by eminent domain by the MDC of Riverdale Parkway. Brookline fought it in the courts and won, so the parkways were not widened or made one-way and the parkway remained under town ownership.

In **1971** Olmsted Park was placed on the National Register of Historic Places along with all of Olmsted' Emerald Necklace Parks. In **1983**, Olmsted Park was designated a landmark by the City of Boston.

In 1982 Brookline installed a gabion system on the west shore of the pond. In 1984 Brookline completed restoration of the third Olmsted Island on the west shore. The planting proved to be less than successful.

The list of Historic Plans and Plant Lists for the Willow Pond Area are contained in the Appendices.

4.6.3.2 Land Use

Land immediately adjacent to Willow Pond is vegetated woodlands and grassy parklands with both paved and unpaved paths. Beyond the woodlands to the east is the Jamaicaway and to the west is Riverdale Parkway. Both separate residential areas from Willow Pond.

4.6.3.3 Active Recreation

Olmsted designed the park as a scenic picturesque park, with activities that were compatible with the enjoyment of the scenery. The pedestrian circulation system around Willow Pond is extant, except for a portion of the footpath on the Boston side at the southern end. On the Brookline side Riverdale Parkway has been converted into a bikeway and footpath. The current footpaths are used for walking. There are also benches for sitting and viewing on the Brookline side, but none on the Boston side.

The Metropolitan District Commission Kelly Rink constructed in 1965 at the junction of Willow Pond Road and The Jamaicaway to the east of Ward's Pond was removed in 1997.

4.6.3.4 Pedestrian Access

Through the Willow Pond area of the project, this assessment focuses on the pedestrian conditions immediately surrounding the Willow Pond along Willow Pond Road. Land uses surrounding Willow Pond are predominantly residential. Pedestrian's demands were collected along Willow Pond Road in July 2000 from 8:00 AM to 6:00 AM on a weekday when the weather was amenable to a pedestrian activity (i.e. warm temperature, no rain). Weekday counts at these time intervals were chosen to be consistent with typical periods of activity for a construction project. Daisy Field, just north of Willow Pond Road, was not in use at the time of these counts. Figure 4-53 presents the pedestrian volumes that were observed. Pedestrian volumes in this segment are much lower than along the Riverway segment to the north.

In general, pedestrian volumes along Willow Pond Road are relatively low. In the morning, approximately 10 pedestrians per hour were observed (at about 10:00 AM). In the evening, there were 30 pedestrians per hour along Willow Pond Road. There are no sidewalks along Willow Pond Road. Given the low pedestrian volume and the relatively low traffic volumes, the lack of sidewalks is not a significant safety issue.

This is adequately served by public transit. There are Green Line subway stations on South Huntington Avenue (Riverway, Back of the Hill, and Heath Street Stations on the E Line) and on Huntington Avenue/Boylston Street (Brookline Village Station near Harvard Avenue, on the D Line). The MBTA bus routes 39, 60 and 66 serves this area along Huntington Avenue, South Huntington Avenue and High Street.

Counts of bicyclists in the area were conducted concurrently with the pedestrian counts. There are no designated bicycle lanes in this area. Observations indicate less than 10 bicyclists during the peak hour of the day in the Willow Pond area along the Jamaicaway and Willow Pond Road. The vehicular travel lanes on the Jamaicaway are narrow, resulting in all bicyclists that were observed using sidewalks or paths. Although Willow Pond Road does not have sidewalks, the lower traffic volumes on this road result in some bicyclists using Willow Pond Road.

4.6.4 Traffic

This discussion of traffic conditions focuses on the Willow Pond area of the project on the Jamaicaway and Willow Pond Road. In the vicinity of Willow Pond, the Jamaicaway is the most heavily traveled roadway. Willow Pond Road connects the Jamaicaway to Pond Avenue. There is a traffic signal at the intersection of the Jamaicaway at Willow Pond Road. The Jamaicaway is a four-lane, MDC roadway that is restricted to passenger vehicles only. Traffic volumes were collected along the Jamaicaway and on Willow Pond Road in July 2000. Table 4-24 and Figure 4-53 summarize these volumes.

Table 4-24
Traffic Volume Summary - Willow Pond Area

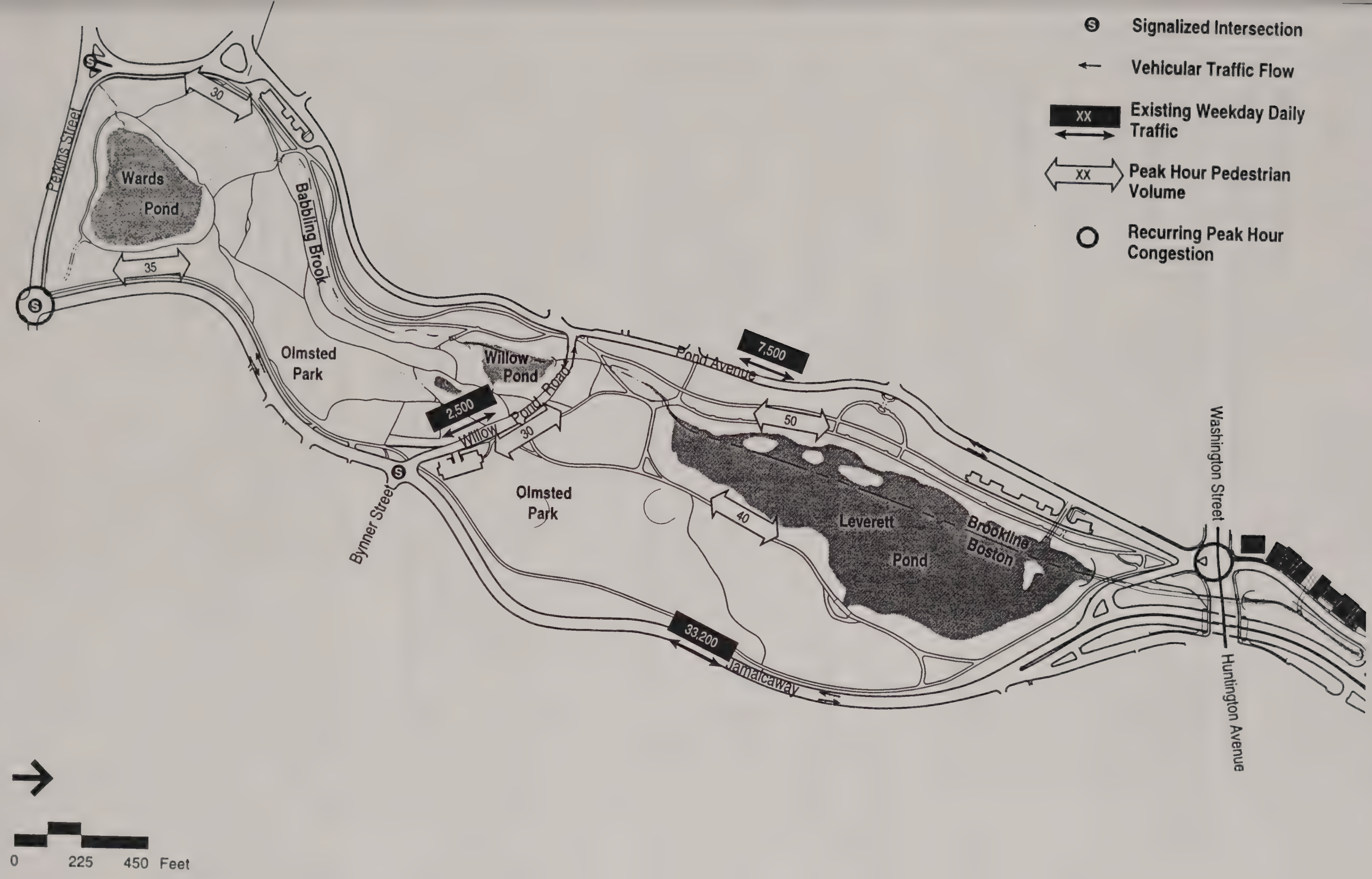
Roadway	Morning Peak Hour Volume (vph)[1]	Evening Peak Hour Volume (vph)	Weekday Daily Volume (vpd)[2]
Jamaicaway - northbound, north of Willow Pond Road	2,100	1,370	17,100
Jamaicaway - southbound, north of Willow Pond Road	840	1,860	16,100
Pond Avenue - just north of Willow Pond Road (both directions)	535	870	7,500
Willow Pond Road - at the Jamaicaway	155	240	2,500

Source: Traffic counts conducted by VHB in July 2000.
1 Peak hour volume, expressed in vehicles per hour (vph).
2 Daily volume, expressed in vehicles per day (vpd).

In the vicinity of Willow Pond Road, the Jamaicaway carries 33,200 vehicles per day. I n the morning peak hour, the Jamaicaway carries 2,940 vph and in the evening peak hour carries 3,230 vph. Pond Avenue carries 7,500 vehicles daily and Willow Pond Road carries 2,500 vehicles daily.

Using the traffic data that we collected, the weekday peak hour periods through the Willow Pond Area were estimated. The morning peak hours occur between 7:30 AM and 8:30 Am and the evening peak hours occur between 5:00 PM and 6:oo PM. These intervals are based on hourly traffic demand fluctuations along the Jamaicaway, north of Willow Pond Road, on a typical weekday (this portion of the Jamaicaway carries the heaviest traffic demands through this area).

The bulk of the traffic in the vicinity of Willow Pond is carried by the Jamaicaway. This is confirmed by the difference in traffic volumes between the Jamaicaway and Pond Avenue. The traffic signal at Willow Pond Road/Bynner Street allows efficient and safe access onto the Jamaicaway from these side streets. The demands on Willow Pond Road and Bynner Street turning onto Willow Pond Road are relatively low, resulting in acceptable operations at this intersection (LOS C or better). However, at times queues from the intersection of the Jamaicaway at Perkins Street extend to Willow Pond Road and effectively block exiting traffic. Although there were no notable operational issues along Pond Avenue in this area, the southbound demands along Pond Avenue increase in the evening peak hour as a result of motorists from Huntington Avenue using Pond Avenue as a bypass of the Jamaicaway corridor.



CDM Camp Dresser & McKee Inc.

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Figure 4-53
Muddy River Restoration
Leverett Pond/Willow Pond/Wards Pond
Area Existing Traffic Conditions

Source: VHB, Inc.

4.7 Ward's Pond

4.7.1 Physical Environmental Features

Steep slopes surround Wards Pond on its east, south and west sides (See Figure 4-54). While Wards Pond is a kettle hole pond that was formed as a large piece of ice was left from the retreating glacier and slowly melted leaving a depression in the surrounding glacial outwash soil. The pond in 1893 was 8 feet deep and approximately 2.3 acres in size. Since Olmsted's design, Wards was dredged once in 1963 when its shoreline was deepened. The center of the pond was reported to be 7 feet at that time. Soundings in 1999 indicate a 4-foot depth.

4.7.1.1 Hydrology

Wards Pond receives the majority of its flow contribution from Jamaica Pond, located upstream. The significant storage and spillway at Jamaica Pond prevents Wards Pond from being inundated with huge flows during significant storms.

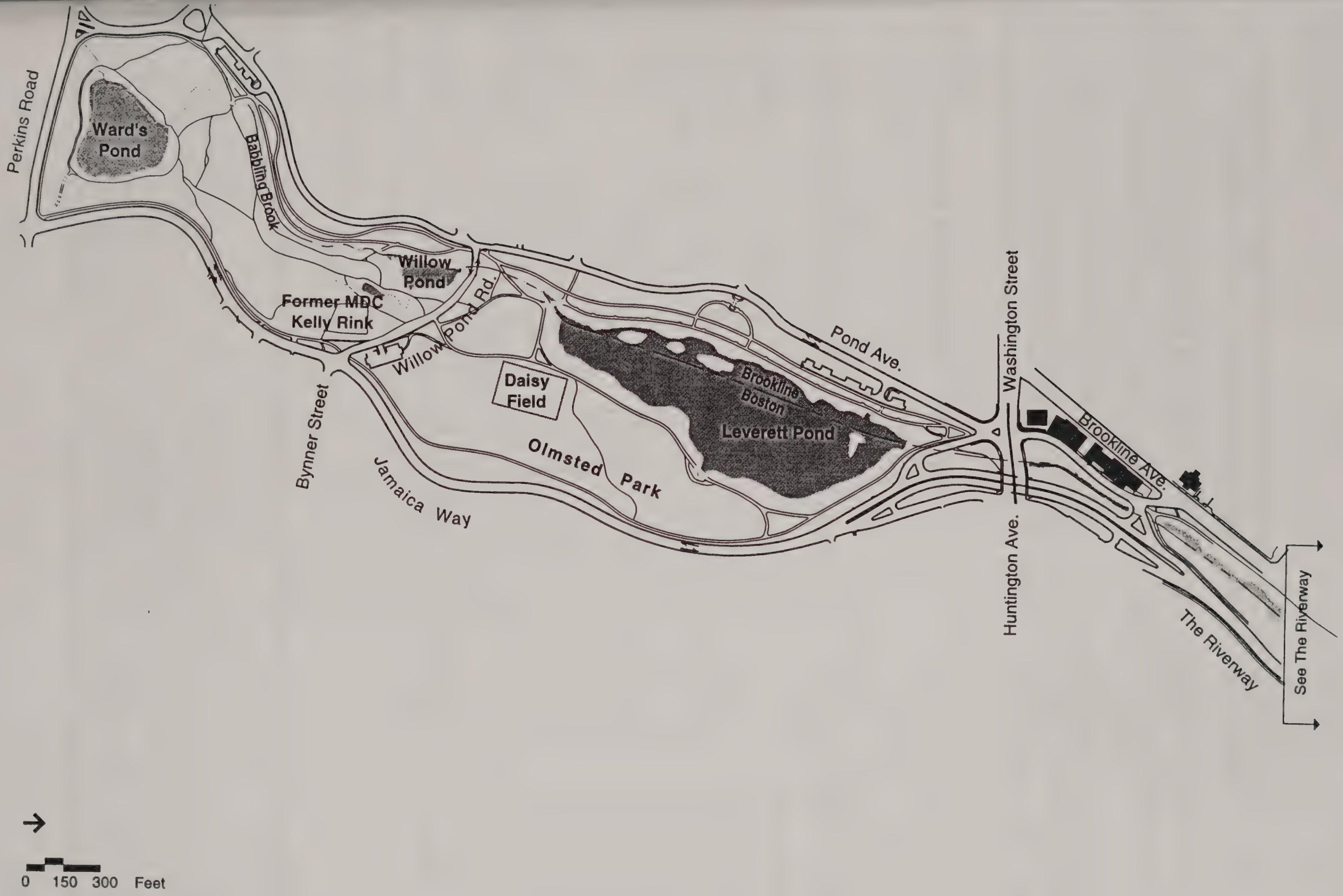
While there is no spillway constructed at the outlet of Wards Pond, the natural discharge channel has a bed elevation of about 45.2 ft BCB, significantly higher than Willow Pond and the rest of the Muddy River continuing downstream. This higher elevation along with the pond's high, steep banks prevent Wards Pond from suffering flood conditions during storms such as the October 1996 storm.

The flow of water from Jamaica Pond can be controlled by stop logs on the spillway (in an underground vault), as well as gate valve that is on a submerged offshore pipe. The gate valve is located within a manhole immediately above Wards Pond. Flow to Wards Pond is controls by the elevation of the stop logs, which set the level in Jamaica Pond. The flow rate varies depending on how much water is entering Jamaica Pond. In the event of pending large storm, the water in Jamaica Pond can be lowered by removing stop logs and spillways.

4.7.1.2 Sediment Quality

The Ward's Pond borings(summer 2000) were completed to a maximum depth of ten feet below the top of sediment or until native material was encountered. The general stratigraphy encountered consisted of varying thickness (0 to 6 ft) of soft, black, organic silt, intermixed with fine to coarse sand and gravel. The native material underlying the silt layer typically was observed at two to eight feet below the top of the sediment. Native material consists of Grey, medium dense to very dense sand with varying amounts of silt and / or fine gravel. Petroleum odors were observed at location WD-SED-1 to depths of six feet below the top of the sediment layer.

The results for the VPH scan showed detectable levels of C_5 to C_8 and C_9 to C_{12} aliphatic hydrocarbons in samples of fill and native material collected at locations WD-SED-1, WD-SED-2 and WD-SED-4. The carbon ranges were not detected in samples collected at locations WD-SED-3, WD-SED-5 and WD-SED-6. Target compounds were not detected in any of the samples analyzed. The sample collected at WD-SED-3 was also analyzed for VOCs by Method 8260. There were no VOC compounds detected. The results of the EPH scan including the target PAH compounds were well below the DEP landfill reuse levels in each of the samples analyzed.



CDM Camp Dresser & McKee Inc.

Figure 4-54
Olmsted Park
Source: VHB, Inc.

The results of the PCB analysis showed concentrations below the 2 mg/kg limit. The results of the pesticide analysis showed detectable levels only in a sample collected from WD-SED-1.

The results of the inorganic analysis generally showed low levels of metals at each of the locations sampled. However, a sample collected from location WD-SED-5, with a total lead concentration of 190 mg/kg, exceeded the TCLP lead regulatory limit with a concentration of 19 mg/L.

The results for reactive cyanide were below the detection limits. A sample collected from location WD-SED-1 exceeded the regulatory limit for sulfides at a concentration of 510 mg/kg. One sample was tested for the paint filter test. The results showed that free liquid was present. The results for Ward's Pond are summarized in Table 4-25.

Table 4-25
Summary of Sediment Analytical Results - Ward's Pond

Contaminant	No. of Samples	Concentration [1] Minimum	Maximum	DEP Landfill Reuse Levels [1] Unlined	Lined	No. of Samples Exceeding Unlined	Lined
Total Arsenic	15	ND	11	40	40	No Exceedances	
Total Cadmium	15	ND	1.8	30	80	No Exceedances	
Total Chromium	15	8.5	34	1000	1000	No Exceedances	
Total Lead	15	ND	1000	1000	2000	1	None
TCLP Lead (mg/L)	4	ND	19	NA	NA	1 Exceeds RCRA [2]	
Total Mercury	15	ND	0.36	10	10	No Exceedances	
Total EPH	15	ND	220	2500	5000	No Exceedances	
Total PCBs	10	ND	1.07	<2	<2	No Exceedances	
Total PAHs	15	ND	35	100	100	No Exceedances	
Total VPH	15	ND	70	NA	NA	No Exceedances	
Total VPH Target	15	Not Detected		4	10	No Exceedances	
Reactive Sulfide	10	ND	510	500		1	1
Reactive Cyanide	10	Not Detected		250		No Exceedances	
pH	10	5.5	6.9	2 < pH < 12.5		No Exceedances	
Conductivity	10	51	330	4000 umhos/cm	8000 umhos/cm	No Exceedances	

[1] All results are reported in mg/kg unless otherwise noted.

[2] Concentration above the federal regulatory limit of 5 mg/L.

The methodology for the sediment test program, analytical results, and summary figures are included in Appendix F.

Elutriate analyses were conducted on sediment from Wards Pond in order to determine, if during the process of hydraulic dredging, if any toxic metals could be released to the environment. The metals that were analyzed included those that are required by the ACOE and the MA DEP, i.e. antimony, arsenic, beryllium, cadmium chromium, copper, lead, mercury, nickel, selenium, silver, thallium, zinc. In the elutriate analysis procedure, sediment is mixed with water at the same general ratio as would occur during hydraulic dredging, i.e. 1 part of sediment to 5 parts of water. The sediment and water are mixed, filtered, and tested. The receiving water is also tested for the same constituents. The difference in concentrations indicate the magnitude of the toxins that could be released during the dredging. The sample location(s) that were selected were done so because the results of the bulk sediment characterization indicated high levels of contamination. An elutriate analysis was conducted on sediment that was collected from Wards Pond at station WD Sed 5) that is shown on Figure F2-6A in Appendix F. The tests on sediment sample WD Sed 5 resulted in the release of 0. 0.061 mg/l of arsenic. The concentration of arsenic that was released is below the acute and chronic freshwater water quality criteria of 0.360 mg/l and 0.190 mg/l, respectively.

4.7.1.3 Water Quality

Wards Pond receives water from Jamaica Pond, groundwater discharge, and some runoff from its steeply sloped watershed. The water from Jamaica Pond flows through a subsurface underwater outlet pipe so the temperature of the water in Jamaica Pond, which is warm in the summer, influences the temperature of Ward's Pond water. There also is an emergency outlet from Jamaica Pond to Wards Pond.

The Massachusetts Department of Environmental Protection has established Water Quality Standards for all waters in the Commonwealth. The Muddy River watershed has been classified as Class B waters. As such, Class B water is also swimmable and fishable.

In order to assess the water quality of Wards Pond, a review of the water quality history was conducted and water was sampled and tested as part of this project. During the recent past, only the Massachusetts Division of Water Pollution Control (now the MA DEP) tested Wards Pond in 1986. These data indicated that the bacteriological, temperature, dissolved oxygen, and pH water quality standards were being met.

While the water quality standards do not have numeric criteria for suspended solids, nitrogen and phosphorus, certain limnological (the study of freshwater ecology) water quality vales were applied to the Muddy River because of its lotic (slow moving) character. These were 20 mg/l for total suspended solids (TSS), 0.30 mg/l for inorganic nitrogen (the summation of nitrate, nitrite, and ammonia nitrogen forms), and 0.01 mg/l for total phosphorus. Applying these values against the historical data it was found that there has not been excessive nutrient conditions in Wards Pond. In keeping with EPA guidance, the Massachusetts Department of Environmental Protection is developing guidelines for nutrient limitations where the technology based point and non-point source pollution controls are not stringent enough to meet the water quality standards. These guidelines are planned to be issued in 2003.

4.7.2 Biological Environment

The resources discussed in this section include upland woodlands, horticultural resources, the aquatic and wildlife resources and wetlands.

4.7.2.1 Upland Vegetation and Horticultural Resources

The inventory, documentation and analysis of vegetation in the Willow Pond Area were completed in August of 2000. The area includes the watercourse from the pedestrian bridge at Ward's Pond to Perkins Street. The scope of work includes trees, shrubs, vines, and lawn areas including notation of areas of bare lawn and areas of erosion.

Vegetation breakdown under trees includes:
Deciduous trees - indicating species, caliper and condition
Evergreen trees - indicating species, caliper and condition
Woodland

Vegetation breakdown under shrubs includes:
Restored planting with five years of restoration
Shrub massings
Invasive plant colony - indicating species

Erosion includes:
Bare lawn
Wash outs of storm sewers
Desire lines
Overuse compaction
Surface roots of trees

Analysis of Existing Vegetation is contained in Table 4-26.

Table 4-26
Inventory and Analysis of Existing Vegetation - Ward's Pond

Category	Unit	Total	Good	Fair	Poor	Dead
Trees:						
Canopy tree	each	136	7	114	15	0
Flowering tree	each	2	1	1	0	0
Evergreen tree	each	0	0	0	0	0
Heritage tree[1]	each	24	1	17	6	0
Total Trees:		**162**	**9**	**132**	**21**	**0**
Shrubs:	(Estimated)					
Restored planting	square footage	0				
Shrub massing	square footage	861				
Total Shrubs:		**861**				
Invasive Plant Colonies:	(Estimated)					
Phragmites	square footage	0				
Other Invasives (e.g.Knotweed	square footage	21,535				
Total Invasive Plant Colonies:		**21,535**				
Woodland:	(Estimated)					
	square footage	**199,247**				

[1] Note: A heritage tree is a canopy tree with a 32" or greater caliper. If it is listed as a heritage tree, it will not be listed as a canopy tree.

In accordance with the Commonwealth of Massachusetts Department of Environmental Management standards, trees that are 32 inches in caliper and over are considered to be heritage trees. All trees have their species and caliper size identified and the condition of the heritage trees is rated as good, fair or poor as are all other trees on the site. The diameter of the circle for tree canopy is in relation to its caliper size.

Plan documentation is contained in Appendix C in the form of annotated Existing Conditions Plans.

4.7.2.2 Aquatic and Wildlife Resources

The aquatic and wildlife resources present at Wards Pond are of a diverse nature and reflect the diversity and good quality of the surrounding habitat as well as the aquatic habitat. Because groundwater seepage as well as direct flow feed Wards Pond from Jamaica Pond, the water is clear, well oxygenated, and provides for a healthy aquatic habitat. The water is warm, however, because of the temperature of water from Jamaica Pond. A Wildlife Habitat Evaluation and Vegetation Assessment of Wards Pond is contained in Appendix D.

Benthic Aquatic Resources

Aquatic benthic resources consist of those organisms, which, through part or all of their life cycles, inhabit the bottom of the resource area. Because of their long-term contact with the bottom sediments and water, the benthic community typically reflects the chemical quality of the sediments and water. The organisms range from those that are pollution intolerant, which inhabit only the cleanest of bottom deposits to pollution tolerant species, which inhabit contaminated sediments, as long as the sediments are not toxic. The benthic community may consist of various fly larvae (e.g. true flies, caddisflies, may flies, stoneflies, dragonflies, etc.), worms, leeches, snails and other species. The benthic community serves as a food source for such bottom feeding fish as the carp, suckers and goldfish. They also serve as food for smaller forage fish species. Ducks and geese also feed upon these organisms.

The sediment in Wards Pond (see Section 4.7.1.2 – Sediment Quality) was found to contain high concentrations of petroleum hydrocarbons, polynuclear aromatic hydrocarbons and heavy metals, particularly lead (see Appendix F). Because some of the sediments were found to contain leachable lead above regulatory criteria, the sediments in Wards Pond are considered to be toxic and hazardous. The following description of the benthic community in and around Wards Pond is based on field observations as well as professional judgement, given the results of the chemical analyses. The following list contains the observed as well as species that are expected to inhabit Wards Pond.

Arthropods
- Insects
  - Chironomids (fly larvae)
  - Gerris (water strider)

Annelids
- Oligochaete Worms
- Leeches

- Dragonfly larvae
- Diving beetles
- Damselfly Larvae
- Northern bluet

Crustaceans

- Amphipods
- Isopods
- Decapoda (cray fish)

Molluscs

- Unionid Clams
- Sphaerid Clams
- Physa snails and other gastropod species

In addition to these species, caddis fly larvae, which, as a group are faciltative to intolerant of pollution have been observed in riffles in the "Babbling Brook" between Wards Pond and Willow Pond.

Fish Resources
Information on fish resources in Wards Pond was gathered through sampling (see Appendix D) and a personal communication with Mr. Andrew Jostlin. These species consist of:

Pumpkinseed	*Lipomis gibbosus*
Bluegill	*Lepomis macrochirus*
Common Shiner	*Notropis cornutus*
Chain Pickerel	*Esox niger*
Large Mouth Bass	*Micropterus salmoides*
Calico Bass	
Bluegill	*Lepomis macrochirus*
Pumpkinseed	*Lipomis gibbosus*
Large Mouth Bass	*Micropterus salmoides*

Wildlife Resources
The wildlife resources of Wards Pond include avian and non-avian species that have been observed either by the public (personal communication with Mr. Andrew Joslin) or through on-site observations that were conducted as part of this project. The Wildlife and Vegetation Assessment that was conducted for this project (see Appendix D) contains further discussions of the wildlife resources at Wards Pond. Wildlife species that have been observed at and around Wards Pond include the following:

Mammals

Eastern chipmunk	*Tamias striatus*
Eastern cottontail	*Sylvilagus floridanus*
Eastern gray squirrel	*Sciurus carolinensis*

Birds

American Crow	*Corvus brachyrhynchos*
American Robin	*Turdus migratorius*
Blue Jay	*Cyanocitta cristata*
European Starling	*Sturnus vulgaris*
Gray Catbird	*Dumetella carolinensis*
House Sparrow	*Passer domesticus*
Northern Cardinal	*Cardinalis cardinalis*

Amphibians

Green frogs	*Rana clamitans*
Bullfrogs	*Rana catesbeiana*

Reptiles

Eastern Painted Turtle
Snapping Turtle
One unidentified turtle, possibly an exotic turtle

4.7.2.3 Rare Species

The Massachusetts Natural Heritage and Endangered Species Program was consulted. Endangered, Threatened Rare species are not reported to inhabit Wards Pond (see Appendix K).

4.7.2.4 Wetland Resources

The wetland resources at Wards Pond were delineated during the spring and summer of 2000. An Abbreviated Notice of Resource Area Delineation (ANRAD), which contained the wetland delineation plans, was presented to the Boston and Brookline Conservation Commissions and accepted by both Commissions in September 2000. A description of the methodology that was used to delineate the wetlands around Wards Pond is provided in Appendix B.

The wetland delineation at Wards Pond resulted in the following resource area findings:

Bank	1,260 sf
Land Under Water	82,764 sf
Vegetation growing in Land Under Water	13,123 sf
Bordering Vegetated Wetland	77,537 sf

The following wetland plants were found to inhabit Wards Pond and the adjacent areas:

jewel weed	*Impatiens capensis*
japananese Knotweed	*Polygonum cupidatum*
speckled alder	*Alnus rugosa*
redmaple	*Acer rubrum*
grey dogwood	*Cornus racemosa*
glossy buckthorn	*Rhamnus frangula*
swamp loosestrife	*Lysimachia terrestis*
sensitive fern	*Onoclea sensiblis*
purple loosestrife	*Lythrum salicaria*
Japanese knotweed	*Polygonum cuspidatum*
specked alder	*Alnus rugosa*
red-osier dogwood	*Cornus stolonifera*
yellow birch	*Betula alleghaniensis*

4.7.2.5 Ecological Functions and Values

An Ecological Functions and Values analysis was conducted by following the US Army Corps of Engineers Highway Methodology (Supplement, November 1995). The purpose of the Functions and Values analysis is to provide as non-biased an assessment of the habitat and wildlife as possible. The results of the functions and values analysis are provided in Table 4-27.

Wards Pond - PRESENT

Wetland Function-Value Evaluation Form

Total area of wetland_______Human made?____Is wetland part of a wildlife corridor? __________or a "habitat island"?

Adjacent land use____Recreation_____________ Distance to nearest roadway or other development________________

Dominant wetland systems present Scrub Shrub/Emergent Contiguous underdeveloped buffer zone

present__No________

Is the wetland a separate hydraulic system?_No_________If not, where does the wetland lie in the drainage basin?______

How many tributaries contribute to the wetland?_1________Wildlife & vegetation diversity/abundance (see attached list)

Wetland I.D.
Latitude______Longitude________
Prepared by:________Date_______
Wetland Impact:
Type_____________Area_______
Evaluation based on:
Office____________Field______
Corps manual wetland delineation
completed? Yes______No_______

Function/Value	Occurrence		Rationale (Reference #)*	Principal Function(s)/Value(s)	Comments
	Y	N			
Groundwater Recharge/Discharge	X		7, 8, 12, 13, 15		Evidence of groundwater discharge from seeps in hillside
Floodflow Alteration		X	3, 4, 5, 9,12		Wetland is not large enough to hold significant amounts of flood waters.
Fish and Shellfish Habitat	X		3, 4, 7, 10, 12, 14		Pond provides fisheries habitat.
Sediment/Toxicant Retention		X	1,2,15		Wetlands are narrow, however provide some sediment retention.
Nutrient Removal	X		2, 4, 6, 9		Wetlands are narrow, however provide some nutrient retention.
Production Export	X		1, 2, 4, 6, 8, 12,		Plants in the wetland provide some wildlife food qualities.
Sediment/Shoreline Stabilization	X		1, 3. 5, 9, 15,		Wetlands are narrow, however provide some sediment retention.
Wildlife Habitat	X		2, 7, 8, 9, 14	X	Diverse area for urban wildlife to exist.
Recreation	X		1, 4, 7, 10, 11, 12	X	Wetland is easily assessable and has a boardwalk. Recreation does occur.
Educational Scientific Value		X	3, 8, 9, 10, 12, 13,		Potential for education site walks. No known educational uses.
Uniqueness/Heritage		X	1, 3, 6, 8, 9, 10, 13, 14, 16, 18,		

Table 4-27
Wetland Function-Value Evaluation Form for Wards Pond

Function/Value	Occurrence Y	Occurrence N	Rationale (Reference #)*	Principal Function(s)/Value(s)	Comments
Visual Quality/Aesthetics	X		2, 7		Wetland is most natural in whole Emerald Necklace System
ES Endangered Species Habitat		X			none found or known to occur here
Other					

*Refer to back up list of numbered considerations.

Notes:

The 13 functions and values that are considered by the Regulatory Division for any Section 404 wetland permit are listed below. The list includes eight functions and five values. Values are grouped together at the end of the list.

These are not necessarily the only wetland functions and values possible. Not are they so precisely defined as to be unalterable. However, they do represent the best working 'palette' of descriptors, which can be used to paint an objective representation of the wetland resources associated with a proposed project.

Groundwater Recharge/Discharge--This function considers the potential for a wetland to serve as a groundwater recharge and/or discharge area. Recharge should relate to the potential for the wetland to contribute water to an aquifer. Discharge should relate to the potential for the wetland to serve as an area where groundwater can be discharged to the surface.

Floodflow Alteration (Storage & Desynchronization)--This function considers the effectiveness of the wetland in reducing flood damage by attenuation of floodwaters for prolonged periods following precipitation events.

Fish and Shellfish Habitat--This function considers the effectiveness of seasonal or permanent waterbodies associated with the wetland in question for fish and shellfish habitat.

Sediment/Toxicant/Pathogen Retention--This function reduces or prevents degradation of water quality. It relates to the effectiveness of the wetland as a trap for sediments, toxicants or pathogens.

Nutrient Removal/Retention/Transformation--This function relates to the effectiveness of the wetland to prevent adverse effects of excess nutrients entering aquifers or surface waters such as ponds, lakes, streams, rivers, or estuaries.

Product Export (Nutrient)--This function relates to the effectiveness of the wetland to produce food or usable products for human, or other living organisms.

Sediment/Shoreline Stabilization--This function relates to the effectiveness of the wetland to stabilize stream banks and shorelines against erosion.

Wildlife Habitat--This function relates to the effectiveness of the wetland to provide habitat for various types and populations of animals typically associated with wetlands and the wetland edge. Both resident and/or migrating species must be considered. Species lists of observed and potential animals should be included in the wetland assessment report.

Recreation (Consumptive and Non-Consumptive)--This value considers the effectiveness of the wetland and associated watercourses to provide recreational opportunities such as canoeing, boating, fishing, hunting and other active or passive recreational activities. Consumptive opportunities consume or diminish the plants, animals, or other resources that are intrinsic to the wetland, whereas non-consumptive opportunities do not.

Education/Scientific Value--This value considers the effectiveness of the wetland as a site for an 'outdoor classroom' or as a location for scientific research or study.

Uniqueness/Heritage--This value considers the effectiveness of the wetland or its associated waterbodies to produce certain special values. Special values may include such things as archeological sites, unusual aesthetic quality, historical events, or unique plants, animals, or geological features.

Visual Quality/Aesthetics--This value relates to the visual and aesthetic qualities of the wetland.

ES **Threatened or Endangered Species Habitat**---This value considers the effectiveness of

the wetland or its associated waterbodies to support threatened or endangered species.
Source: ACOE

Wards Pond is located at the southern-most section of the project area Emerald Necklaces. This portion of the Emerald Necklace is least impacted by pedestrians and has minimal urban development; thus it remains the most natural environment within the Muddy River system. Steep banks that lead to Jamaica Way bound the Pond on the southern and eastern perimeter and the Riverway (roadways).

Wards Pond is approximately three acres in size. The maximum depth of the pond is approximately five feet. The pond is fed by three water sources: a 4' x 3' brick culvert from Jamaica pond, an 8" overflow pipe from Jamaica Pond, and groundwater seepage. There are approximately 0.65 acres of wetlands around the pond. Wetland types consist of emergent in some areas and scrub/shrub throughout.

Sound water quality of Wards Pond supports a diverse and healthy wetland population. No manicured lawns and little erosion of the banks exist at Wards Pond.

Most of the pond's wetlands are classified as scrub/shrub. Shrubs in the area consist of glossy buckthorn (*Rhamnus frangula)*, weeping willow (*Salix babylonica*), river birch (*Betula nigra*), gray birch (*Betula populifolia*), paper birch (*Betula papyrifera*), and arrow wood (*Viburnum dentatum).* The herbaceous layer of plants consist of jewelweed (*Impatiens capensis*), sensitive fern (*onoclea sensibilis*), and purple loosestrife (*Lythrum salicaria*). In many places there are healthy emergent vegetated wetlands extending into the water. Such species include narrow-leaved cattail (*Typha angustifolia*), swamp loosestrife (Lysimachia terrestris), and lily pads. The principal wetland function/values for this wetland system are wildlife habitat, recreation, and product export. The wetlands do function to retain sediments and toxicants, and remove nutrients. However, due to the relative narrowness of the wetlands, this is not a principal system.

The southwest portion of the pond receives a large amount of groundwater via seepage from the hillside. The groundwater is filtered through the emergent/shrub wetland and eventually discharges into the pond.

Due to the narrowness of the wetlands around the pond, flood storage capacity is very low. Hydric soils are present around the wetland and are able to retain some floodwater. There are no storm drains or drainage swale outfalls leading to the wetlands or the pond. However, overland flow may occur. The wetlands do filter some sediments and restrain toxicants from entering Wards Pond.

Wildlife species observed in Wards Pond include a variety of avian, insects, amphibians, and freshwater fishes. Fish present in Wards pond are included in Appendix D. The diverse vegetative community supports a strong diversity of wildlife habitat.

The clear water quality of Wards Pond indicates that sediment retention may occur in the wetland. These wetlands are of high importance because of the potential sources of sedimentation upgradient of the pond (i.e. The Riverway and Jamaicaway).

4.7.3 Cultural Environment

4.7.3.1 Historic Resources

The Ward's Pond Area has a Primary Period of Significance, 1880 to 1895, which is the Frederick Law Olmsted design for the area. In 1880, Olmsted completed a plan for a "Suggestion for the Improvement of Muddy River", which was published in the Sixth Annual Report of the Boston Park Commissioners and in the Annual Report of the Brookline Park Commissioners. The suggested improvement included a diagrammatic plan for the proposed park prior to the 1881 design plan. Frederick Law Olmsted set forth his intent:

> "*Upper Valley of Muddy River -- A chain of picturesque fresh-water ponds, alternating with attractive natural groves and meads.*
>
> *From Tremont Street, southerly to Jamaica Pond, the waters widen out into pools and ponds, connected by a rapid brook. The road on the Boston side has been named Jamaica-way, thus, by change of name, recognizing the change of landscape character. The public way on the Brookline side is named Brookline Road, the use of the word 'road' being appropriate to its rural character.*"

A July 23, 1881 survey titled "Plan of Proposed Muddy River Improvement Showing Contours," prepared by Boston City Engineer Henry M. Wrightman, documented the site prior to the start of Olmsted's work. The Wards Pond site was an existing pond (see Figure 4-55).

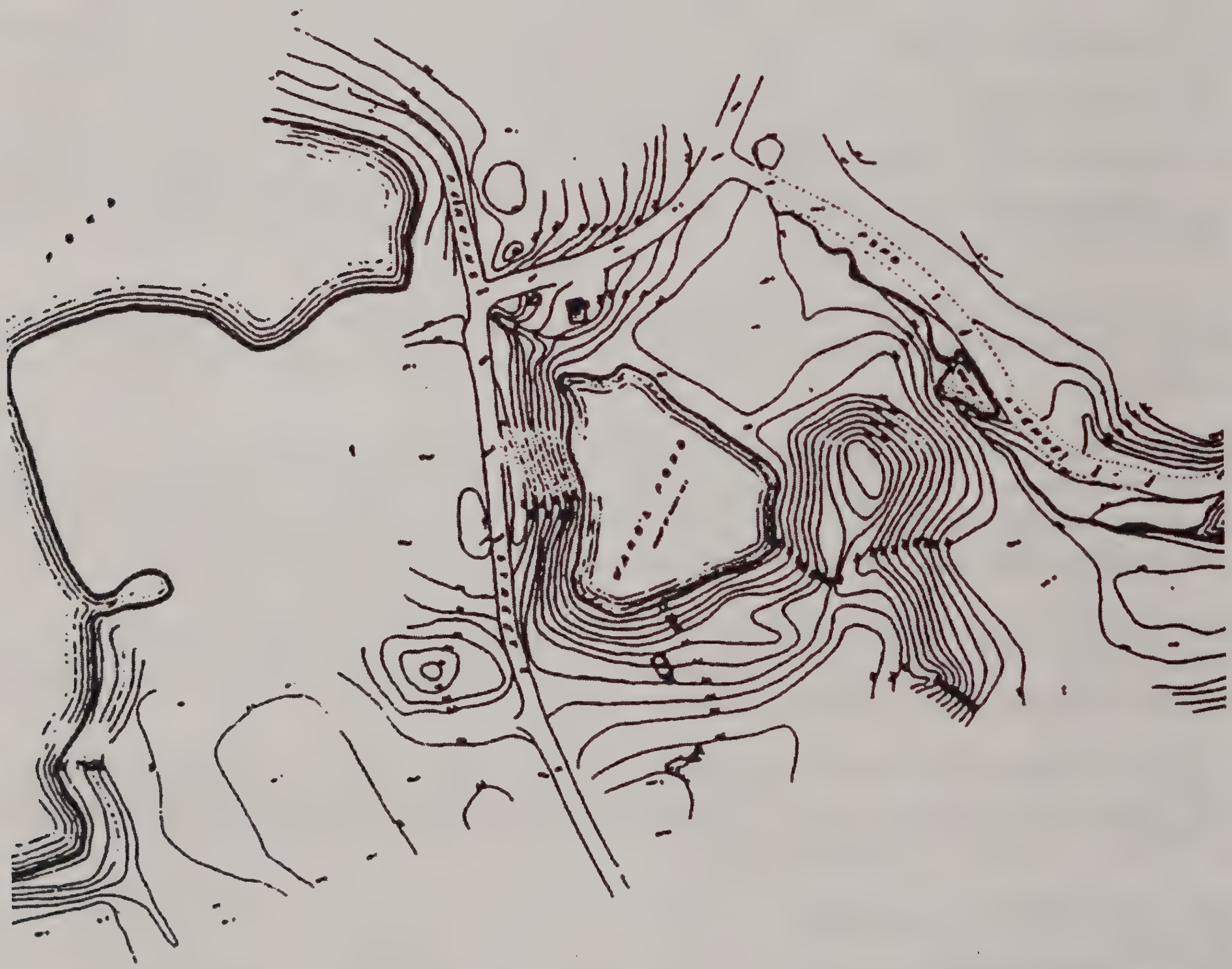


Figure 4-55
Plan for Proposed Muddy River Improvements Showing Contours, 1881
Source: FLOHNS

The 1881 "General Plan for The Sanitary Improvement of Muddy River and for Completing a Continuous Promenade between Boston Common and Jamaica Pond", the 1889 "Outline of Revised Plan for The Parkway and Sanitary Improvement of Muddy River showing the proposed change in the Town boundary and the relationship of the proposed pleasure ground to the neighboring streets and to the lately suggested revisions to the railroad arrangements between Chapel and Longwood Stations.", the 1890 plan published in the Fifteenth Annual Report of the Boston Park Commissioners and the Annual Report of the Brookline Park Commissioners. The 1892 lithograph titled "Plan of the Parkway between Muddy River Gate House and Jamaica Park, the 1896 "Plan of Portion of Park System from Common to Franklin Park document the park during the Olmsted Period. In addition a series of plans dating 1890 to 1893 provide detailed proposed grading, historic shoreline, plant massings with viewsheds, plant lists, and planting plans for the Olmsted design (see Figure 4-56).

Extensive photographic documentation for the pond exists particularly in the early 1900's. These photographs illustrate the shoreline of the pond, the plantings, and original bank treatments, either planted or grass beaches coming down to the edge of emergent vegetation (see Figure 4-57).

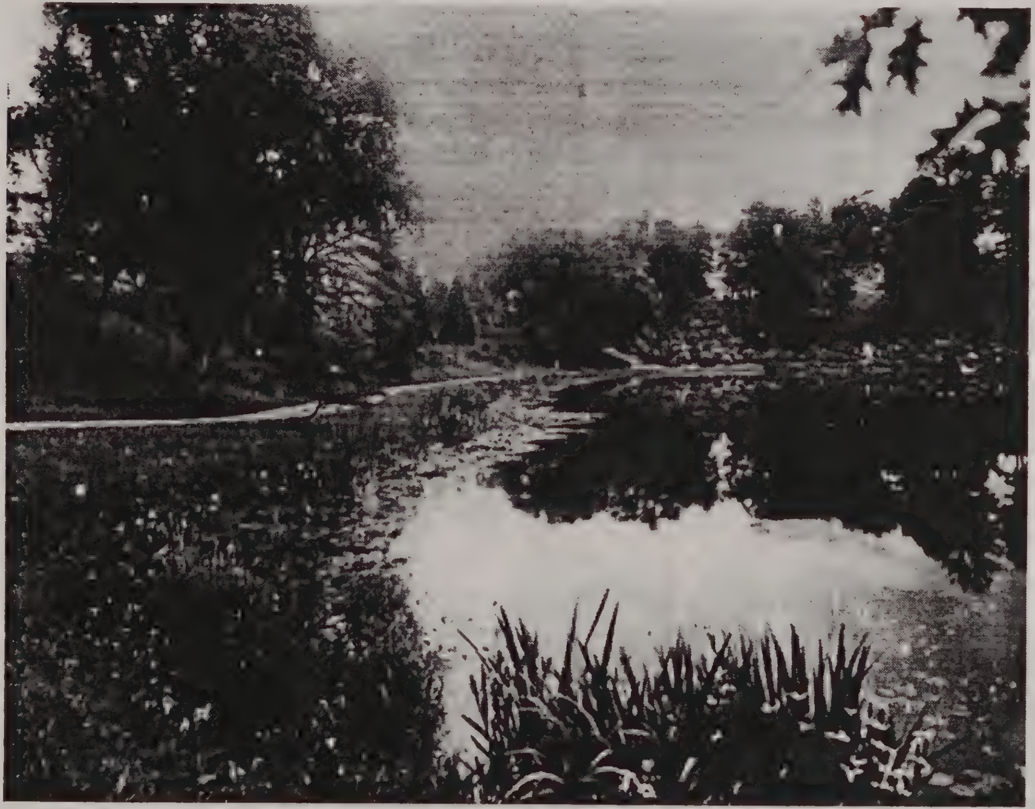


Figure 4-57
View of Ward's Pond Looking Towards Perkins Street, 1904
Source: FLONHS

Complete grading plans exist that delineate the grading and shape of the original shoreline as designed and constructed by Olmsted and his firm in the early 1890's. The plans can be overlayed to the shoreline created during the Primary Period of Significance with surveys showing the existing conditions today, and so determine what areas of shoreline is extant from that period. We also have extensive drawings documenting the planting that was done in Olmsted's time. These include plans showing the intended massing of plant materials and the site direction of dozens of vistas through and

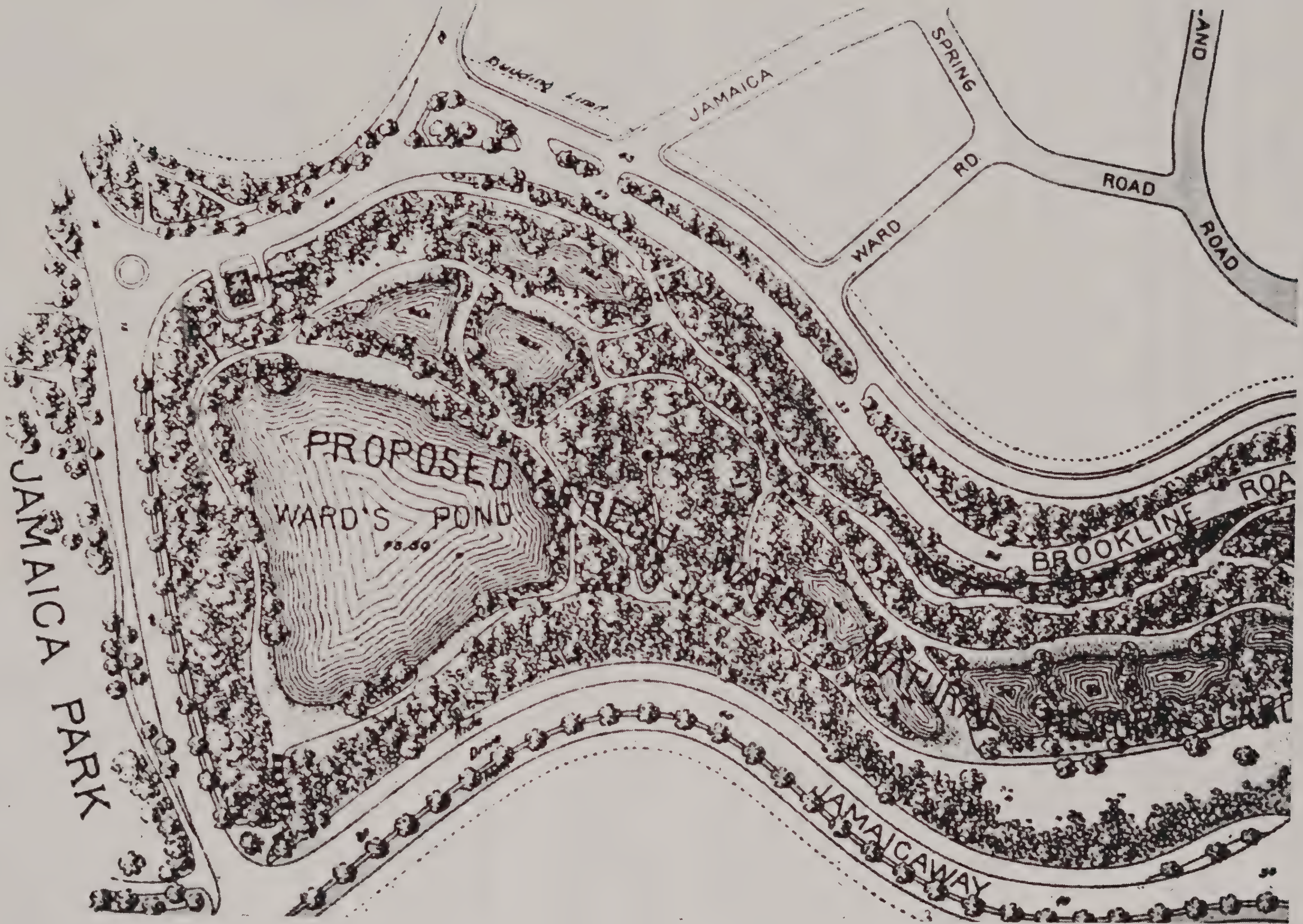


Figure 4-56
Plan of the Parkway Between the Muddy River Gate House and Jamaica Park, 1892
Source: FLONHS

over vegetation, providing views across the pond. Planting plans supplemented by extensive planting lists that identify individual trees and plants or groups of plants to be places in precisely indicated areas. No other park designed by the Olmsted firm during Olmsted's career and with his active participation has nearly as detailed a record of involvement by John C. Olmsted, who carried on the firm's work in the Boston parks after Olmsted's retirement in 1885, and by Warren Manning, the firm's chief plantsman, who had a notable landscape design career of his own beginning in the late 1890's. (See Figure 4-58)

The planting plans and plant list for the entire Boston side of Olmsted Park have been identified and brought together for the first time during the present project. They indicate plant materials not used on the Brookline side that were to supplement those lists. They also indicate the particular conditions of soil and sunshade under which different groups of plants were to be used. The Ward's Pond plans are plant massings, since Olmsted and his firm usually preferred to make planting decisions in the field as the process went on.

Olmsted designed the park as a picturesque park with activities that were compatible with enjoying the scenery. As with the Back Bay Fens and the Riverway, Olmsted constructed circulation system around Ward's Pond. The path systems and the separation of carriage, and foot traffic were the major feature that allowed the passive user to view the picturesque pond landscape, the carriage drive or parkway to view its green edge without causing physical danger or interfering with the experience of the landscape of each. The path system around the pond was complete in 1895, except for the northern side.

Two boulder/culvert bridges were constructed at the north and south ends of the pond. Both bridges provided viewing points or were features set in Olmsted's picturesque views. The area of the history pools west of the pond had two boulder/culvert bridges, which were demolished with the history pools by John A. Pettigrew in 1897. A granite footbridge spans the babbling brook after leaving Ward's Pond.

There is no Secondary Period of Significance since there has been no major designer involved in Olmsted Park since Frederick Law Olmsted's involvement, although the Olmsted Firm did some consulting afterwards. In 1897 John A. Pettigrew was hired, as Park Superintendent for the Boston side and the contract with the Olmsted Firm was not renewed. The decision was made by Pettigrew to fill two of the Natural History pools at Spring Pond (1898), since the Society could not raise funds. By 1899, additional pools were filled, and the boulder bridges were demolished at Wards Pond. Pettigrew also began "rearranging" the plantations, adding broadleaf evergreens with particularly dense plantings on the east and south banks of Wards Pond (see Figure 4-59).

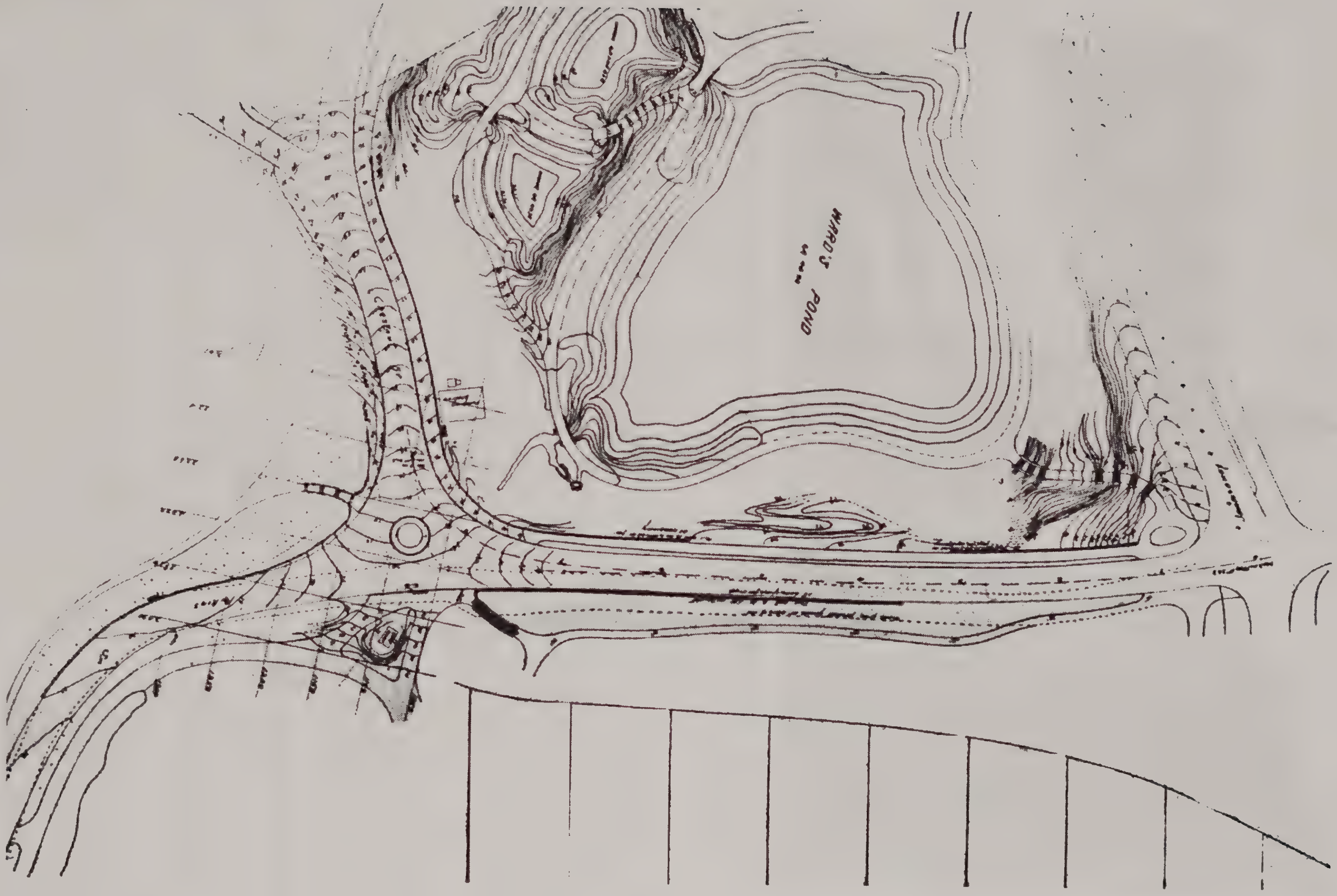


Figure 4-58
Grading Plan at Ward's Pond, 1900
Source: BPRD

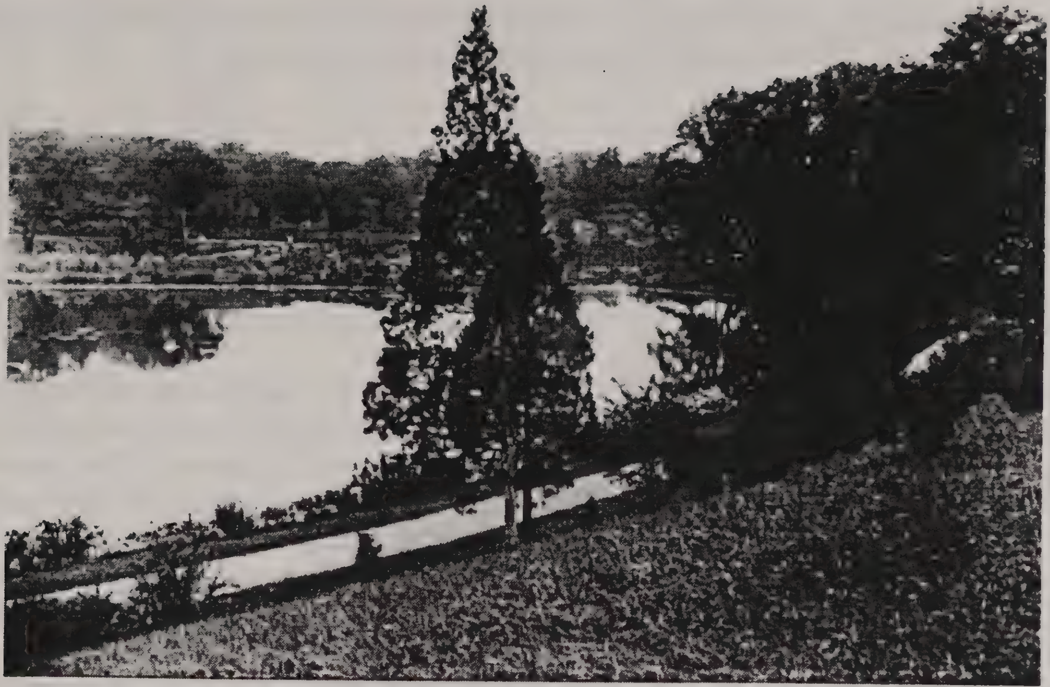


Figure 4-59
Wards Pond from Near Jamaicaway Looking North Towards Chestnut Street, c. 1900
Source: FLONHS

In 1956 the Metropolitan District Commission took care and control of the Jamaicaway, Perkins Street, Chestnut Street and Willow Pond Road as well as a twenty-five (25') foot taking of a right of way into the parkland. Pond Avenue, which dates to the 1881 survey, is the only road surrounding the park that is not under MDC control. In 1956 the Metropolitan District Commission took care, controlled maintenance of the Jamaicaway, Perkins Street, Chestnut Street and Willow Pond Road as well as a twenty-five (25′) foot taking of a right a way into the parkland. Pond Avenue. Which dates to the 1881 survey, is the only road surrounding the park that is not under MDC control.

In 1971 Olmsted Park was placed on the National Register of Historic Places under the National Preservation Act of 1966 along with all of Olmsted's Emerald Necklace Parks. On October 24, 1989, Olmsted Park was designated a landmark by the City of Boston under Chapter 772 of the acts of 1975

Projects completed in Olmsted Park since the adoption of the Emerald Necklace Master Plan are documented in the Emerald Necklace Master Plan contained herein.

The list of Historic Plans and Plant Lists for Wards Pond is contained in the Appendix C.

4.7.3.2 Land Use

Ward's Pond is bordered by residential land use on the east and west and the park to the north and south.

4.7.3.3. Recreation

Ward's Pond is principally a passive area, but has unorganized active recreation with woodland trails for walking and running. Currently there are no benches around the pond.

4.7.3.4 Pedestrian Access

This assessment of pedestrian access focuses on the sidewalks along the Jamaicaway, Pond Avenue, and Perkins Street within the Wards Pond area of the project. Land use surrounding Wards Pond is predominantly residential. Pedestrian volumes through this area were recorded on a typical weekday in July 2000. Figure 4-60 presents the peak hour volumes that were observed. Pedestrian volumes in this segment are much lower than along the Riverway segment to the north.

Approximately 30 pedestrians used the paths on the west side of Wards Pond along Pond Avenue in the peak hour of the day (at about 3:00 PM). 35 pedestrians used the sidewalk to the east of Wards Pond, along Jamaicaway, during the peak hour of the day (at about 12:00 noon). There were no observed pedestrian safety issues. All sidewalks are concrete and are in a good to fair condition.

This area is adequately served by public transit. There are nearby Green Line subway stations on South Huntington Avenue (Riverway, Back of the Hill, Heath Street Stations, E Line) and on Huntington Avenue/Boylston Street (Brookline Village Station near Harvard Avenue, D Line). The MBTA bus routes 39, and 60 serve the area along Huntington Avenue, South Huntington Avenue, and High Street.

Counts of bicyclists in the area were conducted concurrently with the pedestrian counts. There are no designated bicycle lanes in this area. Observations indicate less than 10 bicyclists during the peak hour of the day in the Wards Pond area along the Jamaicaway and Perkins Street. The vehicular travel lanes on the Jamaicaway are narrow, so all bicyclists were observed using sidewalks or paths. Few bicyclists were observed on Perkins Street.

4.7.4 Traffic

This assessment of traffic conditions focuses on the Jamaicaway, Perkins Street, and Pond Avenue within the Wards Pond area of the project. In the vicinity of Wards Pond, the Jamaicaway is by far the most heavily traveled roadway. Traffic volumes were collected along the Jamaicaway in July 2000. Table 4-28 provides a daily and peak hour summary of these traffic volumes on the Jamaicaway and Pond Avenue.

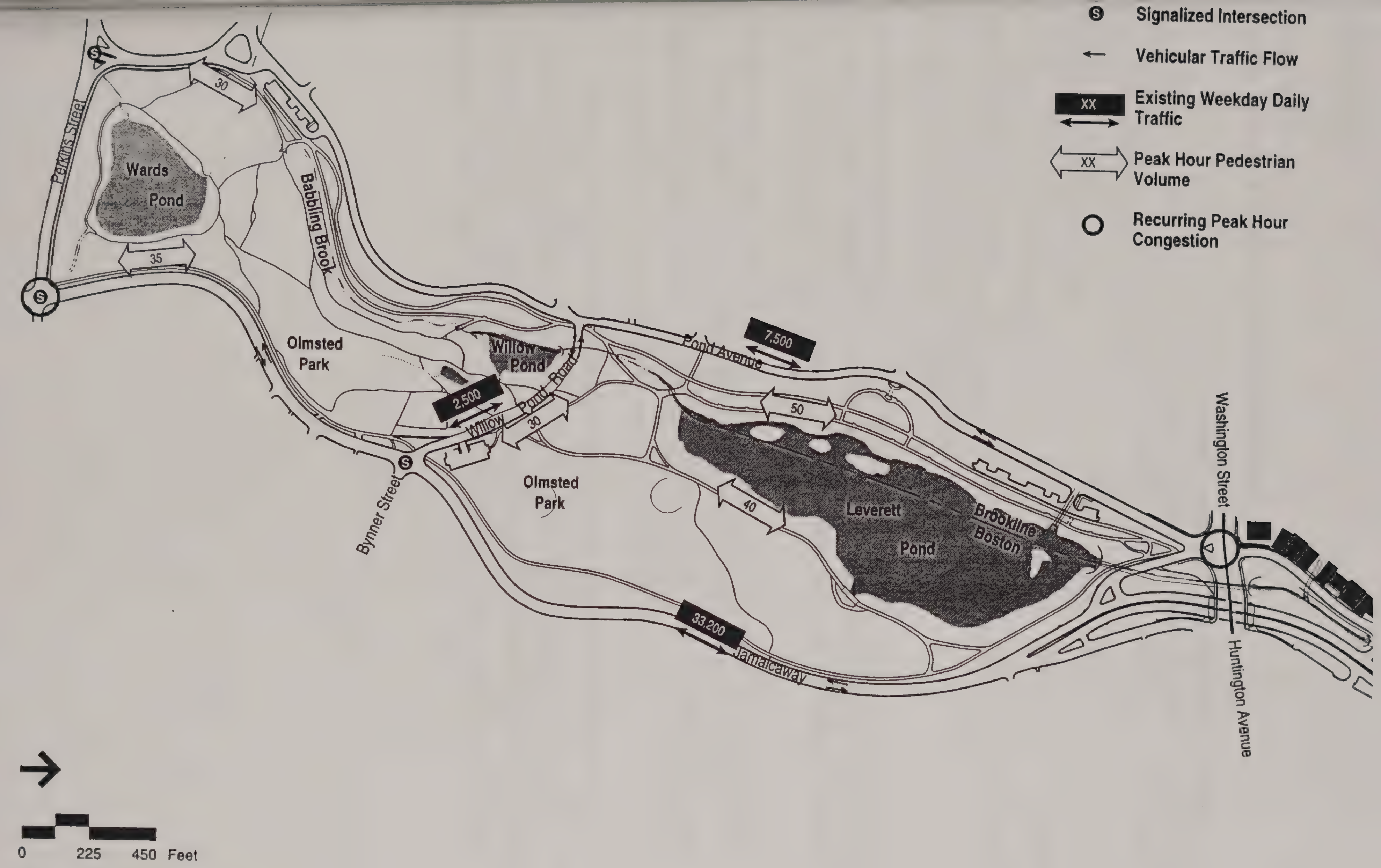


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Figure 4-60
Muddy River Restoration
Leverett Pond/Willow Pond/Wards Pond
Area Existing Traffic Conditions

Source: VHB, Inc.

Table 4-28
Traffic Volume Summary - Wards Pond Area

Roadway	Morning Peak Hour Volume (vph)	Evening Peak Hour Volume (vph)1	Weekday Daily Volume (vpd) 2
Jamaicaway - northbound, north of Willow Pond Road	2,100	1,370	17,100
Jamaicaway - southbound, north of Willow Pond Road	840	1,860	16,100
Pond Avenue - just north of Willow Pond Road (both directions)	535	870	7,500

Source: Traffic counts conducted by VHB in July 2000.

1. Peak hour volume, expressed in vehicles per hour (vph).
2. Daily volume, expressed in vehicles per day (vpd).

In the vicinity of Wards Pond (just north of Willow Pond Road), the Jamaicaway carries 33,200 vehicles per day. In the morning peak hour, the Jamaicaway carries 2,940 vph and in the evening peak hour carries 3,230 vph. Pond Avenue carries about 7,500 vehicles daily. The Jamaicaway is an MDC roadway that is restricted to passenger vehicles only.

Using the traffic data that were collected, the weekday peak hour periods through the Ward's Pond Area were estimated. The morning peak occurs between 7:30 AM and 8:30 AM and the evening peak hour occurs between 5:00 PM and 6:00 PM. These intervals are based on hourly traffic demand fluctuations along the Jamaicaway, north of Willow Pond Road, on a typical weekday (this portion of the Jamaicaway carries the heaviest traffic demands through this area.)

In the vicinity of Wards Pond, the key intersection that experiences recurring congestion is the intersection of the Jamaicaway at Perkins Street. The intersection of the Jamaicaway and Perkins Street is congested during peak hours with vehicle queues extending past Willow Pond Road at times. Although there were no notable operational issues along Pond Avenue in this area, the southbound demands along Pond Avenue increase in the evening peak hour as a result of motorists from Huntington Avenue using Pond Avenue as a bypass of the Jamaicaway corridor.

5

Section Five

Section 5
Project Design and Construction

Project design and construction information for the Muddy River rehabilitation is included in this report section to describe the important considerations for each element of the recommended alternative. Screening of all alternatives was discussed in Section 2 resulting in a summary of the recommended alternatives that are further described in this section.

The recommended project elements in this section are part of the first phase of a larger improvement program outlined in the Emerald Necklace Master Plan. Phase One of the Emerald Necklace Master Plan and the relationship to future phases are discussed in the Executive Summary and Section 1.

This section has been organized according to the geographic segment of the project (Charlesgate, Back Bay Fens, etc.) with Best Management Practices summarized in one subsection. While the BMP elements are covered in one section at the end of this section, we stress that BMPs are as important an element as the other parts of the project. BMPs have been discussed together and by describing them in one location a sense of how they relate to each other is gained.

Since many of the recommended project elements serve to meet multiple project objectives, a table has been included in each geographic segment identifying the project element and how it contributes to meeting each project objective. In Section 2 project elements are screened according to the ability to meet project objectives for the purpose of choosing a recommended set of project actions or elements. This section summarizes the recommended project elements and how each meets the project objectives. Following the summary of objectives, the significant design and construction details of the recommended project elements are discussed. Preliminary design plans are further presented in Appendix I.

Construction staging is discussed in this section in the context of what order the elements of construction need to occur to accomplish the work. In the larger view, the elements of the project as discussed in this section are currently contemplated to be included in two construction contracts. The first contract would include the Charlesgate area, where funding is already available to complete this work. A second construction contract would include the remaining work discussed in this section. At this time, the logic for a second major construction contract is based on obtaining significant funding from a source such as the U.S. Army Corps of Engineers, who would likely manage the construction contract as well as provide funding. A single second construction contract would facilitate management from a single entity with heavy funding. If funding considerations indicate more diverse funding sources where one entity may not be suitable for managing the construction, then several smaller construction contracts may be considered.

Several of the Best Management Practice recommendations will be included as capital items in the construction packages described above. The remaining BMP elements will be implemented separately from the initial capital projects. The responsibilities and schedule for these remaining BMPs are discussed in Section 5.7.

5.1 Charlesgate Area

Construction activities that are proposed within the Charlesgate Area (defined as Ipswich Street to Charles River) include:

- The formation of one staging area for dredging equipment including belt filter presses and appurtenances;
- The removal of waterway obstructions (stop logs forming a weir under the railroad bridge);
- The dredging and removal of approximately 3,300 cubic yards (cy) of accumulated sediment and debris. Included in this total would be about 1,000 cubic yards upstream of Ipswich Street to the Boylston Street bridge to prevent sediments behind stop logs from washing into Charlesgate area;
- The rehabilitation and revegetation of the staging area upon completion of the work;
- The planting of new vegetation;
- The repair or replacement of worn pathways; and
- Installation of new park benches and trash cans.

Project objectives met by the above construction activities are summarized on Table 5-1. Two of the activities address three or more of the project objectives.

5.1.1 Channel Dredging and Dredged Material Management

The Muddy River in the Charlesgate Area will be dredged to increase the available cross sectional area for flood flows. About 3,300 cubic yards of sediment will be dredged from Ipswich Street to the culverts at the Charles River using hydraulic dredging techniques. The dredged bottom elevation will be 1.0 feet BCB. A plan of the dredged area and staging site is included in Figure 5-1.

Included in the 3,300 cubic yards is about 1,000 cubic yards of material just upstream of the stop logs at the railroad bridge. Removal of this material will slope the sediment surface from 1.0 ft. up to the existing level (about 3.0 – 4.0 ft. BCB) between Ipswich Street and Boylston Street. This sloping of the sediment surface will prevent sediments from washing into Charlesgate once the stop logs are removed. The remainder of the sediment upstream of Ipswich Street down to elevation 1.0 feet BCB would be removed with the Back Bay section.

TABLE 5-1
PROJECT OBJECTIVES MET BY CHARLESGATE AREA PROJECT ELEMENTS

	PROVIDE FLOOD CONTROL	*IMPROVE WATER QUALITY*	*ENHANCE AQUATIC & RIPARIAN HABITAT*	*REHABILITATE LANDSCAPE & HISTORIC RESOURCES*	*INSTITUTE BEST MANAGEMENT PRACTICES*
Remove waterway obstructions	Restores flow capacity of river	None	None	None	None
Dredge approximately 3,300 CY sediment	Restores flow capacity of river	Removing sediments will slightly improve water quality in segment of river	Removed sediments will improve bottom habitat and slightly improve water quality	None	None
Rehabilitate & revegetate staging area & disturbed areas	None	Reduces erosion from unvegetated areas	Reduces erosion from unvegetated areas	Rehabilitates degraded landscaping, no historic resources affected	Reduces erosion from unvegetated areas
Replace pathways, benches & lighting	None	None	None	Rehabilitates degraded landscaping, no historic resources affected	None

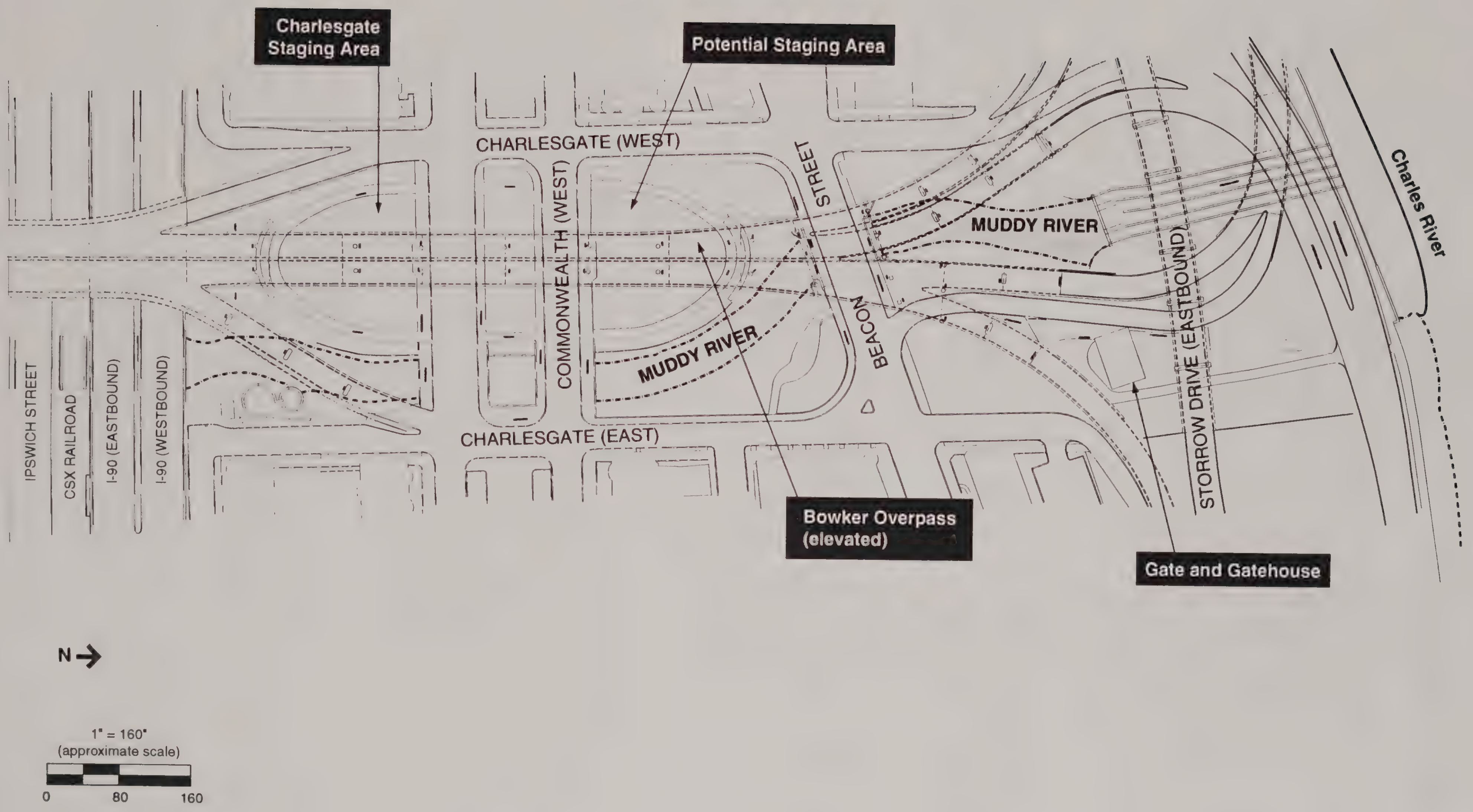

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Figure 5-1
Charlesgate Area

The recommended hydraulic dredging will utilize a "mud cat" type of dredging equipment that includes a cutter head mounted on a floating barge. Water will be pumped through the cutter head creating a slurry of water and sediments that is pumped through flexible piping to a dewatering facility. Belt filter presses mounted on truck trailers will be used to dewater the sediment slurry using addition of polymer as a dewatering aid. The dewatered sediment will be conveyed directly to a watertight dump truck for transportation to the disposal facility. Filtrate from the dewatering equipment will pass through a sedimentation tank and filter before discharging back to the Muddy River. It is anticipated that required permits will limit the suspended solids in return filtrate at 50mg/l as an annual average and a maximum of 100 mg/l.

A staging area under the Bowker Overpass will be created for this portion of the project. The dewatering equipment will be located in the staging area and sediment slurry will be pumped through flexible piping laid in the river bed from the mud cat to the dewatering equipment. Preliminary design plans and specifications for the Charlesgate area are included in Appendix I.

The quality of sediments in the Charlesgate Area indicated in Appendix F will be disposed in an out-of-state landfill under a waste manifest. While the sediments are sufficiently clean to be disposed in an in-state lined landfill, the physical quality of the sediments cannot be used for landfill cover (generally too fine and too wet) and would therefore most likely sent to an out-of-state lined landfill. Disposal cost estimates assume out-of-state disposal. However, if the contractor can find an in-state landfill that can accept the material, the costs will be lower than projected.

5.1.2 Resulting Flood Control

Flooding in the Charlesgate section of the Muddy River results from an inadequate cross sectional area of the river caused by sedimentation and from constraints under culverts caused by control weirs left in place. Correcting these deficiencies will lower the river elevation by approximately 1.2 feet during the design storm (October 1996 storm). Correcting these deficiencies also will provide capacity for passing storm flows once upstream deficiencies are addressed. The proposed improvements in the Charlesgate Area include dredging approximately 3,300 cubic yards of accumulated sediment and removing the weir obstructions under the Ipswich Street culvert as described below.

5.1.3 Construction Staging

The project proponents have funding commitments for construction of the Charlesgate improvements. Charlesgate improvements are limited to dredging for flood control and water quality improvement. It is anticipated that the construction will begin in early 2002.

As part of the initial construction project, the staging area under the Bowker Overpass, adjacent to eastbound Commonwealth Avenue, will be stabilized once the contractor completes the dredging. The staging area likely will be used again during the construction activities for Back Bay Fens. The area on the westbound Commonwealth Avenue end of the Bowker Overpass also may be used if needed for construction staging at Charlesgate. The staging area would be used approximately nine months for the Charlesgate construction.

5.1.4 Traffic Management for Construction

The proposed staging area location for the Charlesgate area is on the south side of Commonwealth Avenue eastbound, beneath the elevated Storrow Drive ramps. The project will not require temporary roadway, lane, or sidewalk closures along Commonwealth Avenue. All equipment will be staged off the existing travelway. The project will require traffic management during mobilization of dredging equipment to/from the staging area, and at times when trucks are entering and exiting.

A key component of construction traffic management is the designation of truck haul routes to be used to haul dried sediment from the staging area and to bring construction materials to the staging area. At this time, the final disposal location for the dried material is not known. Therefore, truck routes to regional highways, such as Route 9, I-90, and I-93, were chosen. From the various possible truck routes, preferred routes were selected based on the nature of the surrounding roadways (i.e. commercial as opposed to residential oriented) and ease of access to the staging areas. Various alternative truck routes to all staging areas were proposed and presented to the Citizens' Advisory Committee and to representatives from the Boston Transportation Department, the MDC, and the Town of Brookline. The overall goal was to gain a consensus on reasonable and appropriate truck routes between the staging area and regional highways.

For the Charlesgate Staging Area, I-93 is the preferred regional route based on ease of access/egress. Using Route 9 or I-90 to access the Charlesgate Staging Area would result in circuitous traffic patterns along roadways through neighborhoods that are not appropriate for truck traffic. From I-93 (Exit 18), the recommended access route follows Massachusetts Avenue to Beacon Street to Charlesgate West. The point of access/egress to the staging area is off Commonwealth Avenue eastbound, as indicated on Figure 5-2. To access the staging area, trucks travel Massachusetts Avenue to Beacon Street to Charlesgate West to Commonwealth Avenue. Leaving the staging area, the truck route follows Commonwealth Avenue to Massachusetts Avenue to I-93. This interchange provides full access to I-93 northbound and southbound. Regional haul routes for all staging areas are shown on Figure 5-3.

Truck haul routes discussed above will address most truck traffic for Charlesgate construction. The contractor will require additional miscellaneous truck traffic for other miscellaneous work and landscaping. The contractor's traffic management plan will include these routes and needs and approval of this plan will encourage use of haul routes where feasible.

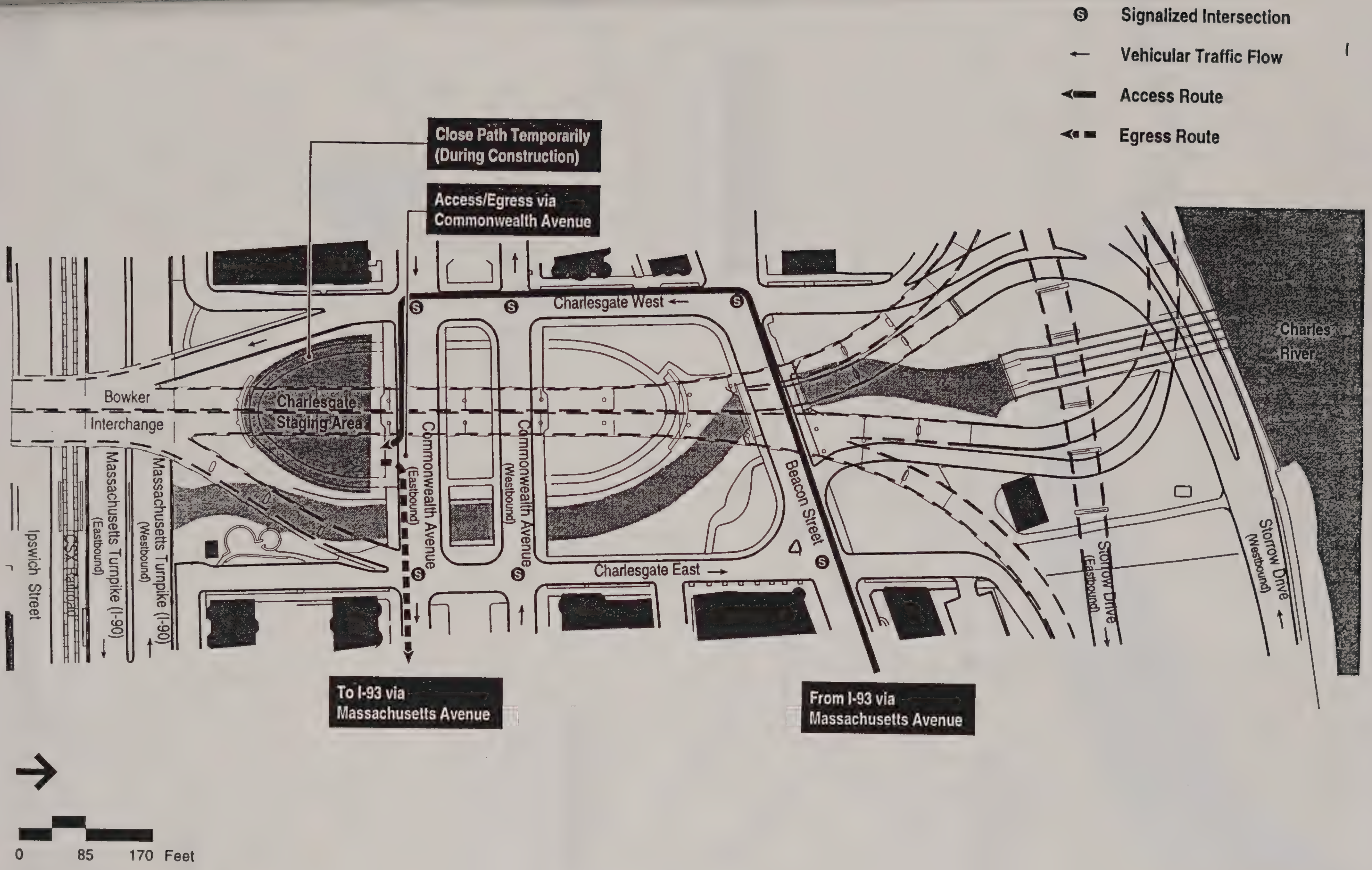
Signalized Intersection
Vehicular Traffic Flow
Access Route
Egress Route
Close Path Temporarily (During Construction)
Access/Egress via Commonwealth Avenue
Charlesgate West
Charlesgate East
Charles River
Bowker Interchange
Charlesgate Staging Area
Commonwealth Avenue (Eastbound)
Commonwealth Avenue (Westbound)
Beacon Street
Storrow Drive (Eastbound)
Storrow Drive (Westbound)
Massachusetts Turnpike (I-90) (Westbound)
Massachusetts Turnpike (I-90) (Eastbound)
CSX Railroad
Ipswich Street
To I-93 via Massachusetts Avenue
From I-93 via Massachusetts Avenue
0
85
170
Feet

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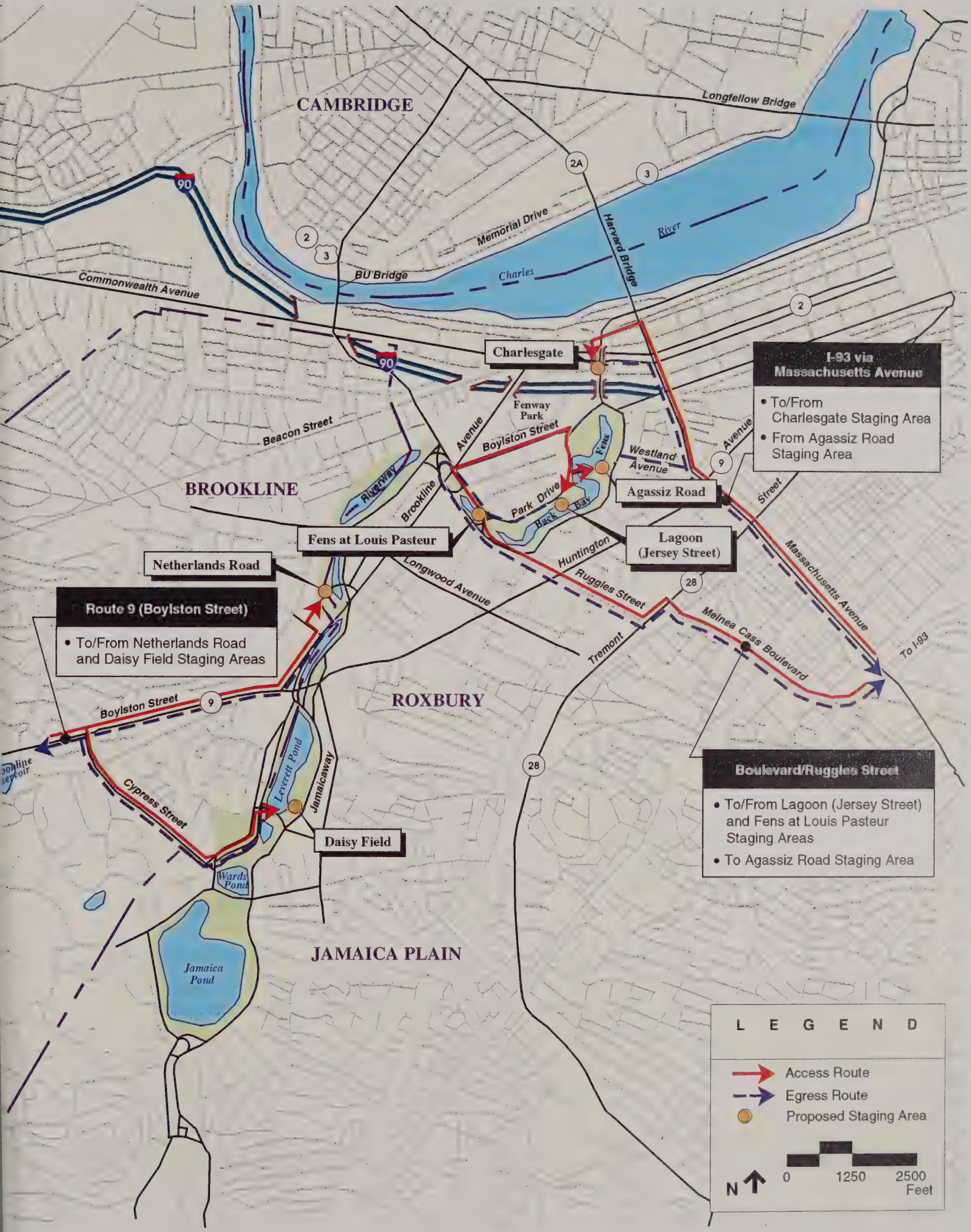
Figure 5-2
Charlesgate Area Potential Staging Area Access/Egress Plan for Construction Traffic

Source: VHB, Inc.



I-93 via Massachusetts Avenue
- To/From Charlesgate Staging Area
- From Agassiz Road Staging Area

Route 9 (Boylston Street)
- To/From Netherlands Road and Daisy Field Staging Areas

Boulevard/Ruggles Street
- To/From Lagoon (Jersey Street) and Fens at Louis Pasteur Staging Areas
- To Agassiz Road Staging Area

Figure 5-3
Muddy River Restoration
Proposed Regional Truck Haul Routes

CDM

5.1.5 Landscape and Historic Resources

The existing Charlesgate site has minimal historical resources or integrity for either the Primary or Secondary Periods of Significance. Nothing remains from the Olmsted Period (Primary) and the balustrade areas are the only features that remain from the Shurtleff Period (Secondary). The existing landscape dates from 1964 and was constructed as part of the Bowker Overpass.

Treatment at Charlesgate will include stabilization of banks after dredging, some in kind[1] repair of existing riprap bank and rehabilitation of landscape in staging area and truck lay-down area. Both the staging and lay-down areas are located under the Bowker Overpass.

In the staging areas to be rehabilitated and other portions of the park disturbed by contractor's operations, rehabilitation will include aeration and soil condition in accordance with standard horticultural practice. Any areas that have been compacted by the contractor's operations will receive the aeration and soil conditioning treatment. The removal of some vegetation will be required to accomplish the work of this project. In addition, the project plans call for the removal of Japanese knotweed that is growing in the Charlesgate area. The upland vegetation adjacent to the project areas, and upland vegetation within staging areas and access points, will be protected to their drip line, pruned and fertilized as a means of minimizing impact to them. The protected areas will be restored in kind as required by post-construction. Protection of plant material and new plantings will be completed under the supervision of a certified arborist, professionally trained horticulturist, or experienced landscape contractor as necessary.

The Gate and Gatehouse (see Figure 5-1) are the only character defining features from the Primary Period (Olmsted) and the balustrade areas are the only features that are extant from the Secondary Period (Shurtleff). During construction the historic features will be protected as required from contractor's operations. It appears they may be sufficiently outside of the operation area to not need special treatment. The balustrade will be protected with wood if contractor's operations are anticipated nearby.

Replanting in the Charlesgate staging area will be a two-stage process. After the staging area is used for work on the Charlesgate dredging, it will be loamed and seeded or covered with gravel. (Gravel to be used in shaded areas.) This is a temporary restoration since the staging area is expected to be used once again for the dredging in Back Bay Fens. The final rehabilitation according to the design plans will begin when the contractor vacates the area for the last time.

In general terms, replanting in staging areas and other disturbed areas will be dependent on the schedule of the work and optimum planting seasons. As dredging and bank stabilization work is completed, the contractor will be expected to provide temporary erosion control measures and then provide landscaping during the next planting season (generally spring and fall). The staging areas are expected to be the last areas vacated by the contractor, so they will be rehabilitated and replanted once the contractor removes equipment from the staging areas at the completion of the work. Temporary erosion control measures will be used in the staging areas until the next planting season when vegetation is replanted.

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[1] "in kind" meaning replace or repair existing items to the same conditions as before construction using the same kind of materials and techniques.

In all replanted areas, the contractor will begin a two-year guarantee and maintenance period once provisional acceptance is made of the planted material.

Preliminary design plans (L-1 to L-5) included in Appendix I show the proposed treatment in the Charlesgate area.

The cost estimate for the project includes the amount for designing and rehabilitating those areas disturbed during construction in the Charlesgate area. These areas would be returned to conditions similar to the current conditions although updated to be consistent with more recent design elements in the Emerald Necklace.

The rehabilitation of the Charlesgate staging areas and areas disturbed during construction will be subject to a public review process. Plans for the final rehabilitation will be developed with the MDC and then reviewed in a public review process prior to finalizing the plans for construction. A public review process is expected to comment on the appropriateness of the new design elements and if they should revise the current layout (horseshoe pathway layout). Comments are also expected on elements such as seating, lighting and trash receptacles and the relationship of the design to the Emerald Necklace Master Plan and the MDC Master Plan for the Historic Charles River Basin.

5.2 Back Bay Fens

Construction activities that are proposed within the Back Bay Fens area (defined as The Riverway at the former Sears parking lot to Ipswich Street) include:

- The formation of three staging areas for sediment dewatering equipment and the loading of sediment into trucks;
- The improvement of the flood carrying capacity via the dredging and removal of approximately 96,500 cubic yards (cy) of accumulated sediment and debris;
- The preservation of the historic park shoreline through the removal of approximately 23,500 cy of *Phragmites* and the rehabilitation of the natural bank;
- Revegetation of the staging areas upon completion of the work;

- The preservation of the historic park features by the revegetation of the new bank, and the establishment of wetland areas under the rehabilitation of terrestrial habitat with indigenous plantings;
- Daylighting of presently culverted sections at the Fens Bridge and the former Sears parking lot;
- Construction of a new 10 ft. by 16 ft. arch culvert under The Riverway at the former Sears parking lot while maintaining the twin 72 inch diameter pipelines under The Riverway;
- Construction of a new 10 ft. by 24 ft. arch culvert under Brookline Avenue at the Sears rotary with an overflow to the Muddy River Conduit;
- Dredge culvert under the Fens Bridge, rebuild upstream headwall and restore downstream headwall; and
- The repair or replacement of worn pathways and denuded ground including re-established pathways.

Project objectives met by the above construction activities are summarized on Table 5-2. Six of the activities address three or more of the project objectives.

5.2.1 Channel Dredging and Dredge Material Management

Hydraulic modeling shows that a channel section 30 feet wide at the bottom with 4 to 1 side slopes and an invert of 2.03 feet BCB reducing to 1.03 feet BCB from the Sears parking lot to Ipswich Street will be required to convey the design flood flows through the Back Bay Fens. This provides sufficient hydraulic capacity for increased flows anticipated from the improvements discussed for the Sears parking lot to the Fens Bridge area. Figures 5-4 and 5-5 show the proposed channel locations. Several cross sections along this channel are shown of Figure 5-6. Upstream of the lagoon area, the minimum channel dredging required for flood control is the entire channel. Cross sections in this area are in Appendix I.

Dredging in this section includes completing the partial removal of sediments between Ipswich Street and Boylston Street (Richardson Bridge) started during dredging of the Charlesgate section. *Phragmites* removal between Ipswich Street and Boylston Street would also be conducted as part of the Back Bay Fens work and not part of Charlesgate.

Dredging in the Back Bay Fens area will be conducted using hydraulic dredging equipment and dewatering as discussed in Section 5.1.1. Four staging areas are proposed for dewatering equipment in this area. The Charlesgate staging area would be reused for the lower portions of the Back Bay Fen's area. The Agassiz Road staging area may be used for dredging from Ipswich Street to Agassiz Road. A staging area at the Lagoon area would be used for dredging between Agassiz Road and Evans Way

TABLE 5-2
PROJECT OBJECTIVES MET BY BACK BAY FENS AREA PROJECT ELEMENTS

	PROVIDE FLOOD CONTROL	*IMPROVE WATER QUALITY*	*ENHANCE AQUATIC & RIPARIAN HABITAT*	*REHABILITATE LANDSCAPE & HISTORIC RESOURCES*	*INSTITUTE BEST MANAGEMENT PRACTICES*
Dredge approximately 96,500CY of sediment	Restores flow capacity of river	Removing sediments will improve water quality in river segment	Removing sediments will improve bottom habitat and improve water quality	Restores historic capacity and shape of river channel	None
Remove approximately 23,500 CY of Phragmites and restore bank	Prevents future encroachment into floodway that would reduce flood capacity	None	Results in more diverse aquatic and riparian habitat	Removes invasive plant material from historic landscape	None
Re-vegetate disturbed bank areas and establish wetland areas	None	Reduces erosion from unvegetated areas	Results in more diverse aquatic and riparian habitat	Rehabilitates landscape treatment from Olmsted plant list	Reduces erosion from unvegetated areas
Re-vegetate disturbed construction areas including staging areas	None	Reduces erosion from unvegetated areas	Results in more diverse aquatic and riparian habitat	Rehabilitates landscape treatment from Olmsted plant list	Reduces erosion from unvegetated areas
Daylight culverted river segments at former Sears parking lot and at the Fens Bridge	Increases flow capacity of infrastructure to pass design storm with lower flood levels	None	Adds new areas of wetland and riparian habitat to river	Rehabilitates historic elements of river sections and restores landscape treatment	None
Add new 10 x 16 food arch culvert to existing 72 in dia. culverts at The Riverway	Increases flow capacity of infrastructure to pass design storm with lower flood levels	None	None	Improves headwall treatment more in line with historic context	None
Construct new 10 x 24 foot arch culvert under Brookline Avenue	Increases flow capacity of infrastructure to pass design storm with lower flood levels	None	None	None	None
Dredge Fens Bridge culvert and restore headwalls	Increases flow capacity of infrastructure to pass design storm with lower flood levels	None	None	Rehabilitates upstream headwall covered in previous filling, restores downstream headwall	None
Repair/ replace pathways and re-vegetate desire lines and unplanted areas and re-establish pathways	None	Reduces erosion from unvegetated areas	Results in more diverse aquatic and riparian habitat	Rehabilitates landscape treatment from Olmsted plant list	Reduces erosion from unvegetated areas

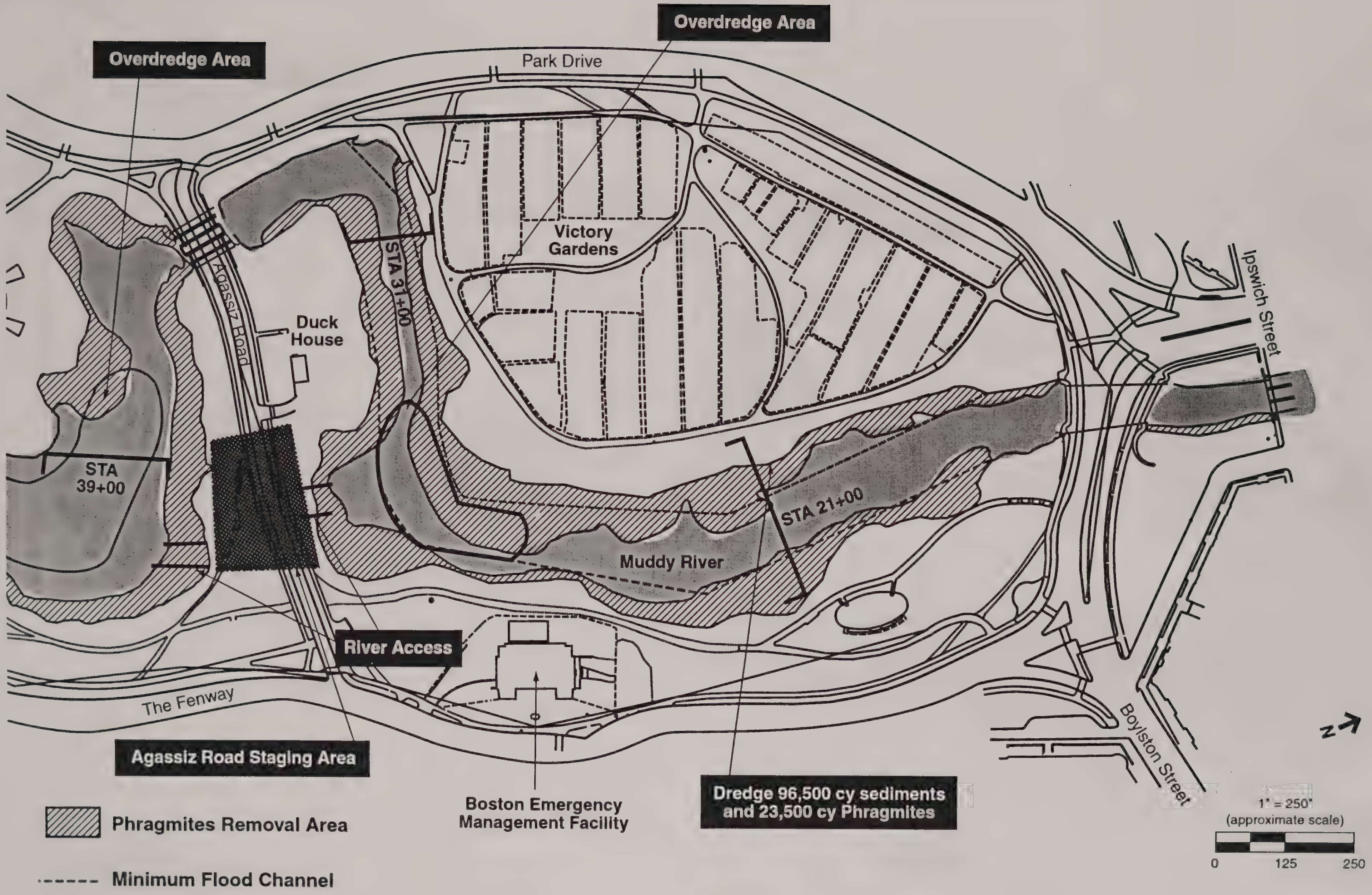

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Figure 5-4
Lower Fens Northern Basin and Cross Section Locations

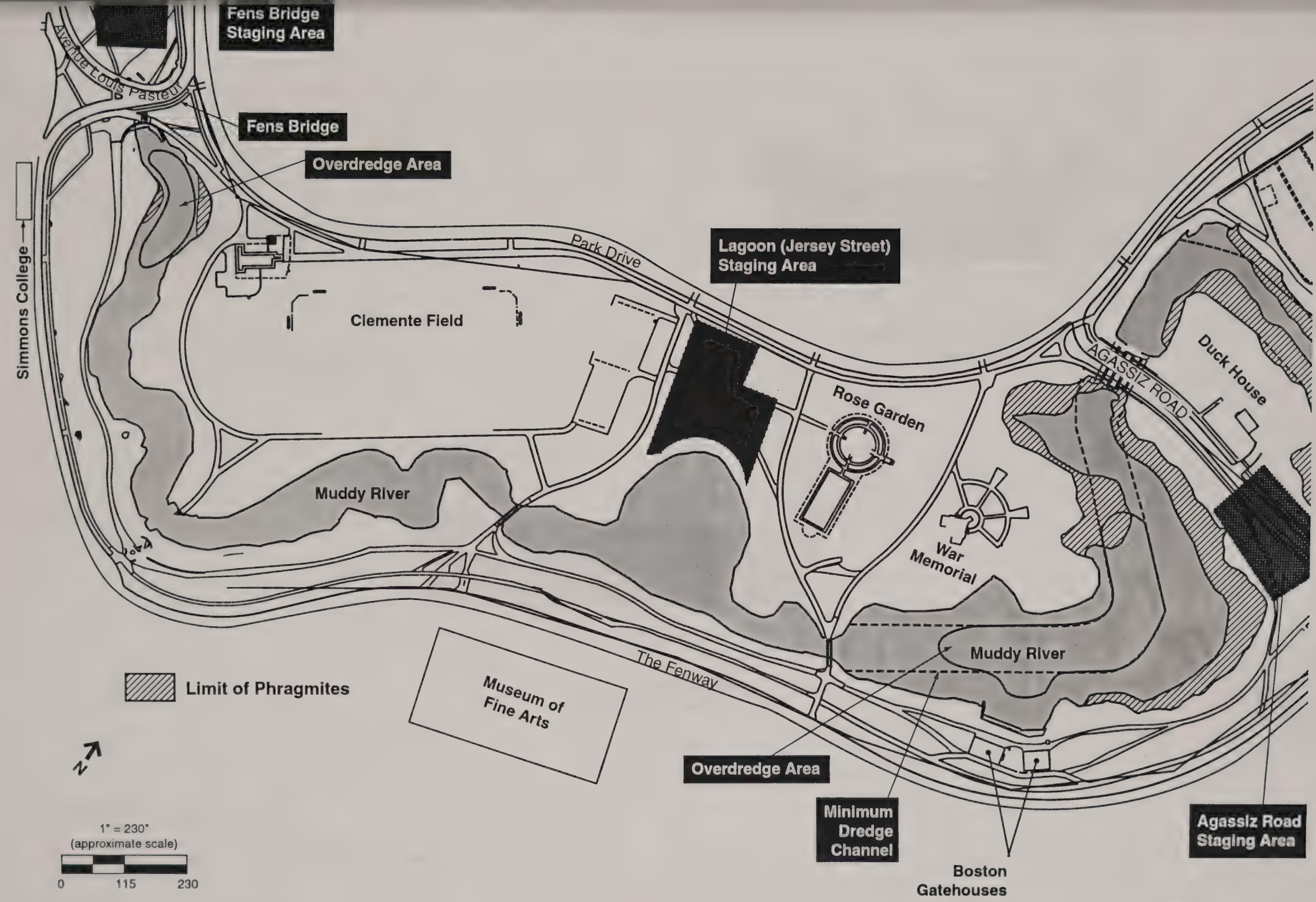

Figure 5-5
Lower Fens Southern Basin Channel Location

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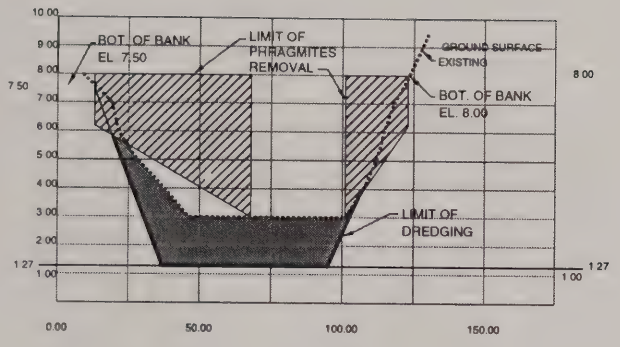
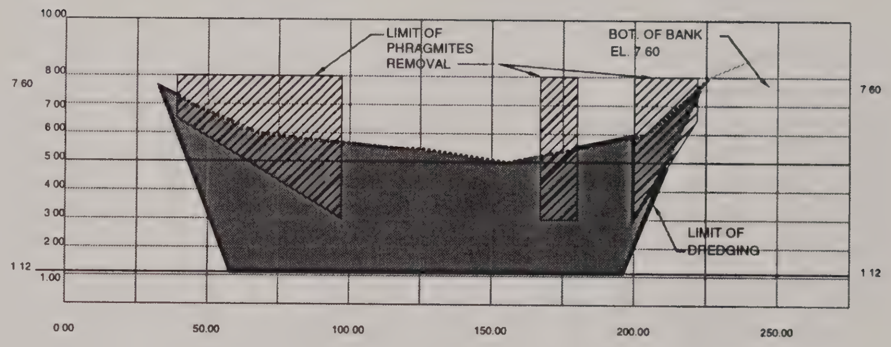
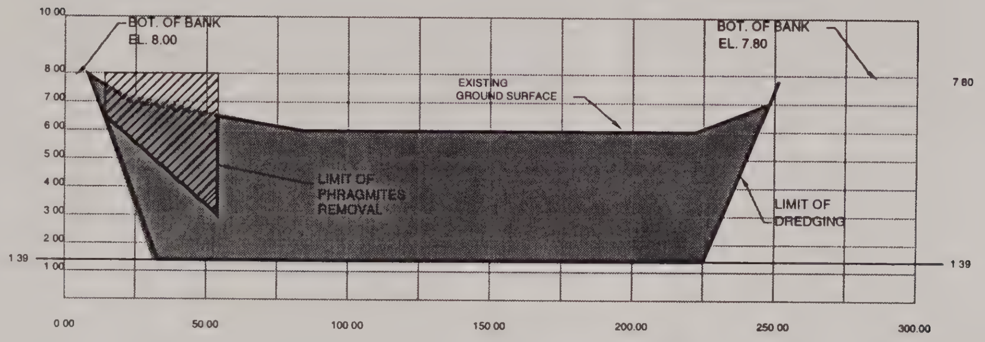


DREDGE CROSS SECTION
AT STATION 31+00



DREDGE CROSS SECTION
AT STATION 21+00



DREDGE CROSS SECTION
AT STATION 39+00

Boston City Base Datum (BCB)

Location of Cross Sections Shown on Figure 5-3

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Figure 5-6
Cross Sections of Back Bay Fens

along the river. The area upstream of The Fens Bridge at Avenue de Louis Pasteur (site also known as Higginson Circle) would be used for staging dredging downstream to Evans Way.

Closing Agassiz Road between Park Drive and The Fenway will create the Agassiz Road staging area. During construction the contractor will be required to maintain a temporary pedestrian pathway along one side of the site. Access to the river on either side of Agassiz Road closest to the Hemenway Street side could be provided with little loss of existing trees. The access is principally vegetated with *Phragmites* that, once removed, will be replaced with historic wetland and emergent plantings.

In addition to dredging sediments along the Back Bay Fens area, invasive species (*Phragmites*) will be removed using mechanical means. The *Phragmites* will be removed using backhoe equipment mounted on barges from the water. Stalks of the *Phragmites* will first be hand cut and removed by barge to the staging areas. The *Phragmites* roots will be excavated using the backhoe and the material taken out through the staging areas. Once the *Phragmites* roots are removed any shore areas disturbed will be refilled and reshaped to the historic shoreline. This will allow a shelf to be reestablished for wetland planting along the water's edge. The areas of *Phragmites* removal are shown on Figures 5-4 and 5-5.

Sediment along the Back Bay Fens area varies in quality as discussed in Chapter 4. Disposal of the sediments would be consistent with the figures in Appendix F. In the final design documents, the plans will be delineated consistent with Appendix F, and will direct the contractor to dispose of sediments in the designated disposal categories based on acceptance of the data by the disposal site operators. A total of 96,500 cubic yards of sediment and 23,500 cubic yards of invasive species will be removed for disposal. Approximately 65,000 cubic yards of the material will be disposed at an out-of-state landfill. Another 27,800 cubic yards of material is considered hazardous material contaminated with lead that exceeds the regulatory leaching potential. The lead-contaminated material will be stabilized through treatment in containers at the staging areas. Chemical immobilization can be used to stabilize the sediments in order that they can be disposed in an out-of-state lined landfill.

5.2.2 Daylighting of Culverted Sections

Two piped sections of the Muddy River will be daylighted in the Back Bay Fens area. The section under the former Sears parking lot and the section upstream of The Fens Bridge both will be daylighted. Daylighting returns these two river segments to nearly the historic configuration of these segments while also increasing the flow capacity.

5.2.2.1 Former Sears Parking Lot

The most upstream daylighted section will be in the former Sears parking lot. Daylighting in the former Sears parking lot area returns this area to nearly the configuration designed by Olmsted and provides significant relief for flood flows. In the early 1940's, plans were made to create a traffic rotary in front of the Sears

Building. By 1948, these plans were under construction with the extension of the twin 72 inch culverts and eventually included the filled land to widen some of the roadways in the rotary. By the early 1950's, it was already apparent that flooding was occurring as a result of the culverts under the rotary. In 1954, the BPRD sold the land to Sears where upon it was converted to a parking lot by 1959. As part of the development process for the Landmark Center, the former Sears parking lot area was returned so that a missing link of the Emerald Necklace could once again come under control of the BPRD. The property was transferred back to BPRD in 1997.

Daylighting will occur between the downstream headwall of the enlarged Riverway culvert and the new Brookline Avenue culvert (see Figure 5-7). Daylighting will return the piped section of the river to the original Olmsted configuration as much as possible. The daylighted area will be excavated to the Olmsted cross section and grades where possible. At the upstream end near The Riverway headwall, daylighting will be shifted south of the historic shoreline from the Olmsted period. About 80 feet downstream of The Riverway culvert headwall, the daylighting will match the historic shoreline configuration until about 30 feet upstream of the Brookline Avenue headwall. At this point, the shoreline will be modified slightly from the historic configuration in order to blend into the proposed culvert and gatehouse.

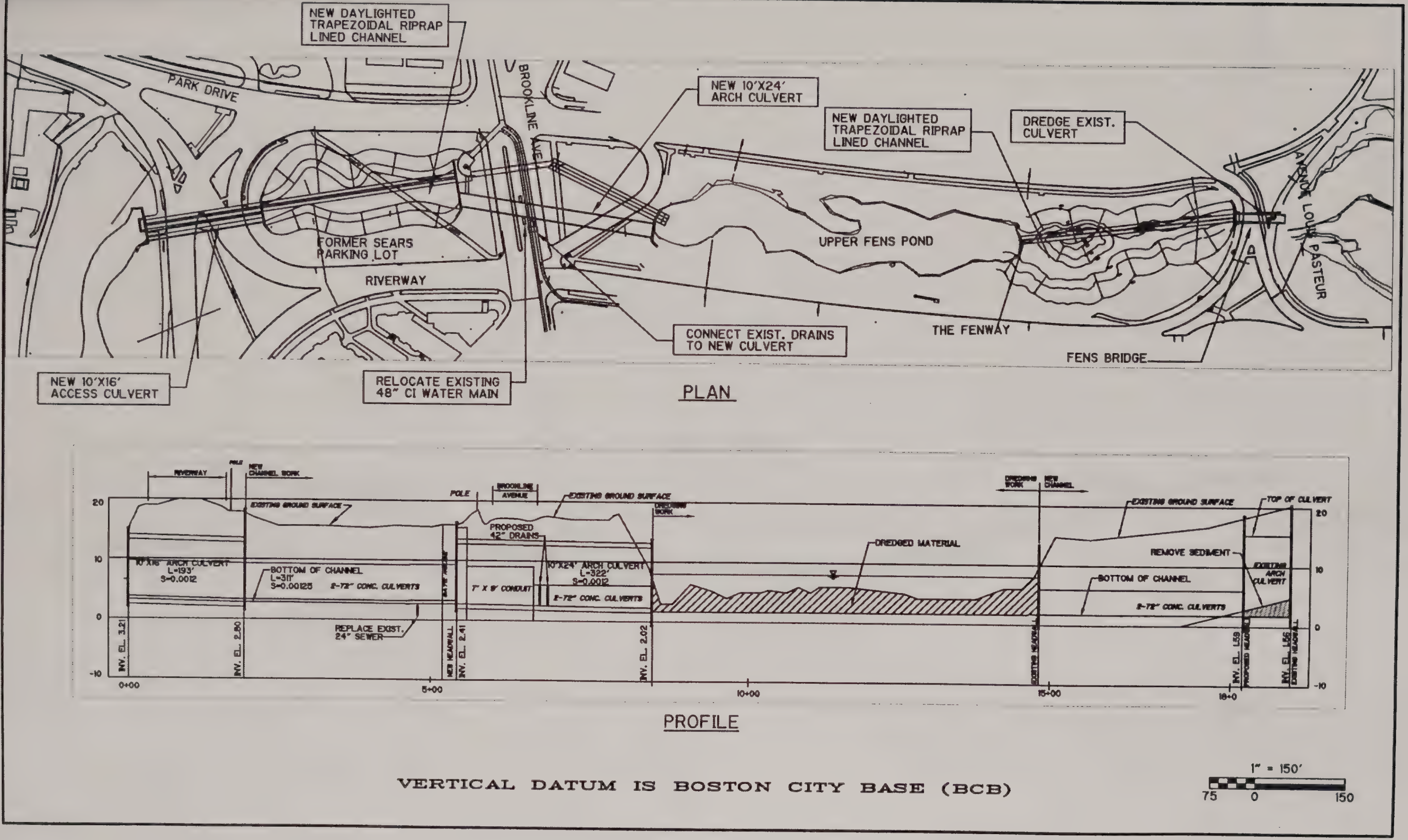
The typical cross-section of the daylighted section (see Figure 5-8) will have side slopes approximately 4 horizontal to 1 vertical. The water elevation will be approximately 8 feet (BCB) with an invert elevation in the channel of 5 feet (BCB). A shelf will be constructed at the waterline to facilitate planting of emergent wetland species along the water's edge. The underwater section of the channel will be lined with dumped stone to protect the bottom from excess erosion. The stone will extend up to the waterline but not above the waterline.

A single 24-inch sewer passes under the daylighted section that will have to be reconstructed as part of the proposed channel section.

New pedestrian pathways and a bike pathway will be constructed between the daylighted section and the adjacent roadway connecting to the pedestrian and bike access along upstream and downstream park sections. Existing road crossings for the pedestrian and bike pathways will be utilized since most were upgraded recently. If new Sears rotary configurations are constructed then crossings would be included in the design.

5.2.2.2 Upstream of The Fens Bridge

The area north of the Fens Bridge was also planned for a traffic rotary, and the installation of the twin 72 inch pipelines was a prelude for a rotary construction similar to that at the Sears rotary. For reasons not clear at this time, the land was never transferred from BPRD and the rotary was never built, although the new pipelines contribute to local flooding to a lesser extent than the Sears pipelines.



VERTICAL DATUM IS BOSTON CITY BASE (BCB)

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Figure 5-7
Flood Control Facilities
Riverway to Avenue Louis Pasteur

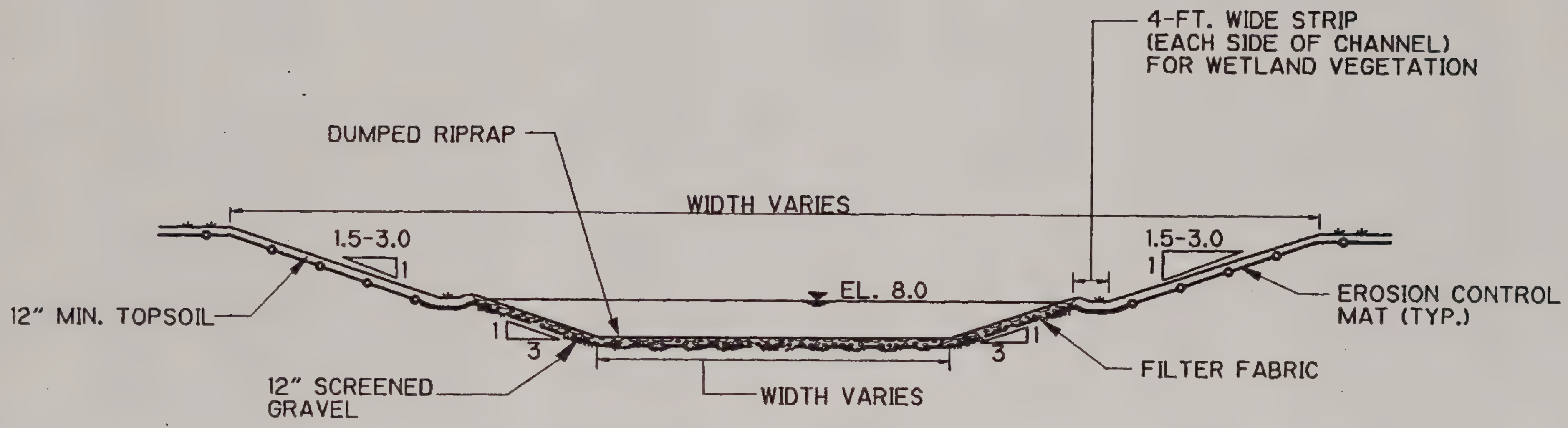

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Figure 5-8
Cross-Section of a Daylighted Channel

Daylighting in the Fens Bridge area will be an historic restoration of the original Olmsted design. Figure 5-7 shows the proposed configuration that includes reconstructing an historic island in the river channel and matching the historic shoreline. The water elevation will be approximately 8 feet (BCB) with an invert elevation in the channel of 2 feet (BCB). The hydraulic capacity of this channel will significantly exceed the capacity of the existing twin 72-inch pipelines under the filled area significantly. Once construction is completed the two 72 inch concrete pipelines will be demolished and removed.

The cross section through the daylighted section will be similar in design to the cross section at the former Sears parking lot. It will include wetland and emergent planting at the water's edge once construction is completed.

At the downstream end of the daylighted section, the two 72 inch pipelines enter a box structure built against the old upstream headwall of The Fens Bridge. The box structure was designed to serve as a transition between the two 72 inch pipelines and the single culvert under The Fens Bridge. Once the two 72 inch pipelines are removed, the box structure will also be removed and the former historic headwall on The Fens Bridge will be restored.

New pedestrian and bike pathways will be constructed along the daylighted section between the daylighting and adjacent roadway similar to the former Sears parking lot area.

5.2.3 Culvert Enlargement

Three culverted sections in the Back Bay Fens require enlargement to pass the design flood flows with acceptable water elevations. These three sections are The Riverway, Brookline Avenue and The Fens Bridge (enlarged by removing accumulated sediments). The culverted sections are connections between the open channel sections and daylighted sections along the Muddy River in the Back Bay Fens.

5.2.3.1 The Riverway

The existing twin 72 inch concrete pipelines under The Riverway will be paralleled with a new 200 foot long 10 ft. by 16 ft. arch culvert to the south of the twin pipelines (see Figure 5-7). The twin 72-inch concrete pipelines will be retained as culverts and used to channel the river flows during construction.

A new headwall will be constructed on the upstream side of the culvert incorporating the existing twin 72-inch culverts and the new 10-ft. by 16-ft. arch culvert. The headwall will be faced and finished with stone in the style of the cut granite stone used in the Olmsted designed bridges. The downstream headwall will be of the same design and also incorporate all culvert pipes in the single headwall.

The existing bar rack structure on the upstream side of the culvert will be removed and no bar rack will be placed on the culvert. The shorter culvert section can be maintained from either end of the structure and the design is made to pass debris through the structure downstream.

It is anticipated that 3 trees would be removed for this construction. No trees removed would be heritage trees and all are in fair condition. The largest tree would be a 24-inch diameter oak on the Riverway Island.

All of the structures under The Riverway will be supported on pile foundations with concrete caps due to the poor bearing capacity of the soils. Foundation recommendations are contained in Appendix I.

Construction of the culvert is expected to use an open cut method in segments across The Riverway. The roadway will be shifted to one side of the construction area and the piles will be placed for the first segment of the culvert. The first segment of the culvert will be constructed. Once the first segment is complete, the roadway will be moved over the completed segment of culvert and the next segment of culvert constructed in a similar manner. See Figure 5-9.

5.2.3.2 Brookline Avenue at Sears Rotary

The twin 72-inch concrete pipelines that pass under The Riverway and former Sears Parking lot enter the Muddy River Conduit diversion structure just upstream of Brookline Avenue. During storm events some of the flow is diverted from the Muddy River to the Muddy River Conduit which discharges to the Charles River. The majority of the flow continues beyond the diversion structure through a single 7-ft. by 9-ft. pipeline. Just downstream of Brookline Avenue the single pipeline discharges to twin 72-inch pipelines that discharge into the Upper Fens Pond. The single 7-ft. by 9-ft. pipeline is crossed by two drainage pipelines in Brookline Avenue that discharge to the Muddy River Conduit. Where these two drain lines cross the single 7 ft. by 9 ft. pipeline carrying the Muddy River they reduce the cross sectional area of the 7 ft. by 9 ft. pipeline and contribute significantly to the reduced capacity of the piped Muddy River in this area.

To relieve the flow constraint in the piped Muddy River a new 10 foot by 24 foot arched culvert will be constructed across Brookline Avenue at the Sears rotary as shown on Figure 5-7. The arched culvert will begin at a headwall at the downstream end of the daylighted section in the former Sears parking lot and continue about 250 feet to a new headwall in the Upper Fens Pond.

The two drain lines in Brookline Avenue will be connected directly to the arched culvert rather than to the Muddy River Conduit as presently exists. Connecting the drains directly to the arched culvert will reduce the cost of connecting the storm drains. Connecting the drains to the arched culvert also reduces flow to the Muddy River conduit that suffers from flooding. Hydraulic modeling (Appendix E) shows that the additional flows can be accommodated by the increased capacity of the downstream dredged channel.

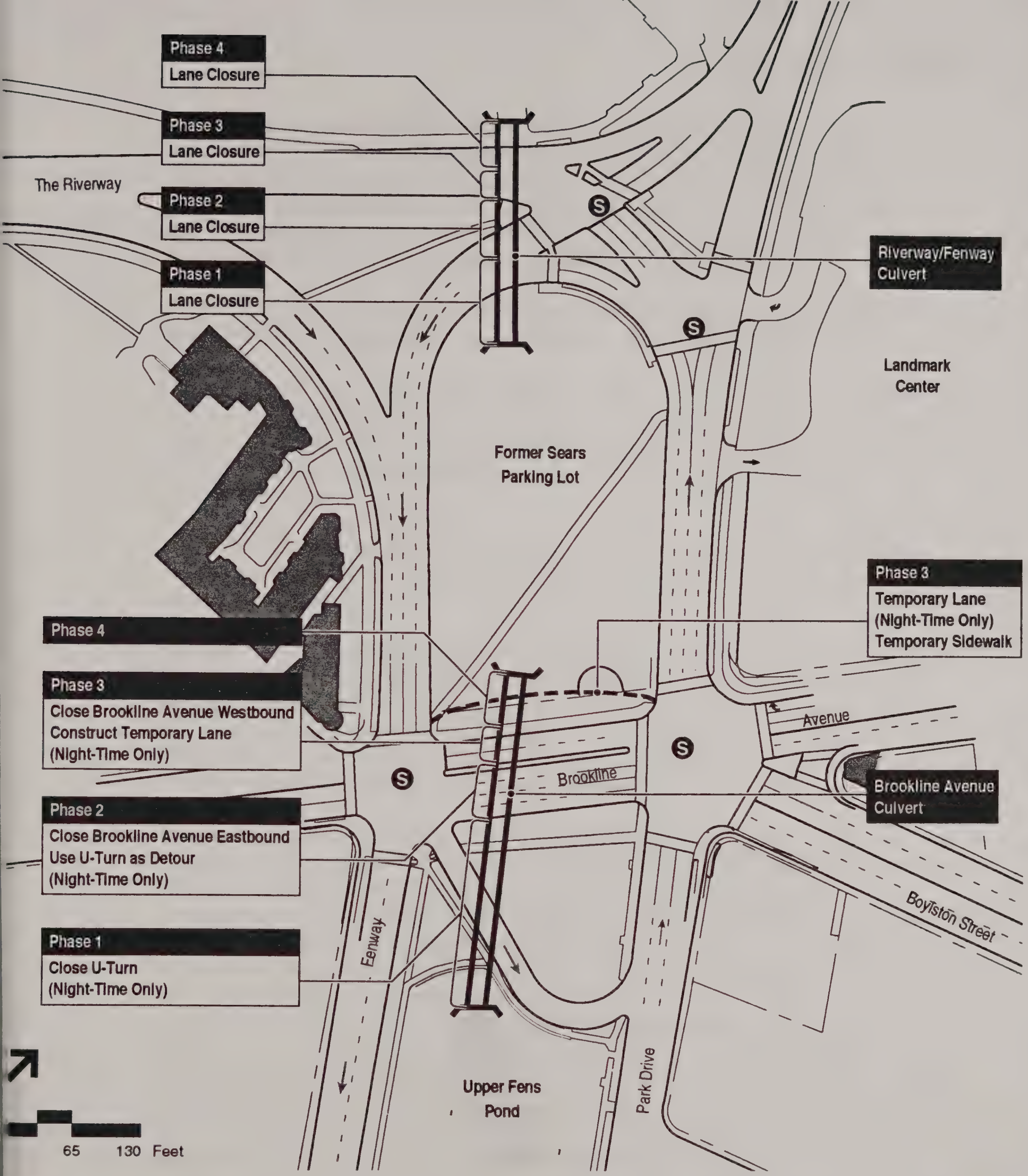

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Figure 5-9
Back Bay Fens Area Sears Rotary
Proposed Culvert Replacement
Implementation Plan
Source: VHB, Inc.

In order to continue to provide for overflow of excess flows from the Muddy River to the Muddy River Conduit, a connection will be constructed between the new arched culvert under Brookline Avenue to the diversion structure (see Figure 5-7). The connecting pipe will be 96 inches in diameter. Diversion of flows from the Muddy River is anticipated to be lower than the existing river system since the downstream system will have greater capacity than the current conditions.

At each end of the Brookline Avenue culvert a new headwall will be constructed. The headwall will be finished in the style consistent with historic considerations.

It is anticipated that 10 trees may be removed for the culvert construction. The largest tree is a 24-inch diameter oak, with several 10-inch diameter oaks and 2 smaller maples. The trees are half fair and half good. A nearby heritage oak is not expected to be disturbed. Some replacement trees can be planted to either side of the completed culvert.

All of the structures for the Brookline Avenue culvert and the connecting pipelines will be supported on pile foundations with concrete caps due to the poor bearing capacity of the soils.

Construction of the culvert is expected to use an open cut method in segments across the Brookline Avenue. The roadway will be shifted to one side of the construction area and the piles will be placed for the first segment of the culvert. The first segment of the culvert will be constructed. Once the first segment is complete the roadway will be moved over the completed segment of culvert and the next segment of culvert constructed in a similar manner. (See Figure 5-9.)

The preceding discussion of the new Brookline Avenue culvert assumes that the "jug handle" turnaround between Brookline Avenue and the Upper Fens Pond remains in place. Discussions taking place by the Fenway-Kenmore Neighborhood Transportation Association that include the Boston Transportation Department and Boston Redevelopment Authority have considered removing the "jug handle" as part of an overall improvement to the Sears rotary. Removing the "jug handle" would provide the opportunity to reduce the length of the Brookline Avenue culvert and extend the Upper Fens Pond closer to its historic configuration. From a cost perspective, excavating additional open channel for Upper Fens Pond would be less costly than the Brookline Avenue culvert structure supported on piles. The extended Upper Fens Pond would also provide equivalent if not better hydraulic conditions during flood flows. Environmental impacts would be similar to upstream and downstream daylighting segments. If the Sears rotary discussions result in a projected change in the "jug handle," a project change notification would be considered for the Muddy River project to modify the Brookline Avenue culvert layout.

5.2.3.3 Fens Bridge

The hydraulic capacity of the culvert under the Fens Bridge is sufficient for the design flow provided accumulated sediments are removed. The 16-foot wide culvert will be repaired as necessary based on an analysis of the structure during the design phase, and the headwalls will be restored. The downstream headwall will require repairs due to vegetation growing between the placed stones. The upstream headwall has been partially demolished as part of the placement of a junction box against the headwall to provide a transition between the two 72 inch pipelines and the culvert under The Fens Bridge. The transition box will be removed and the headwall restored to the historic form and function.

It appears that there will be minor disruption to the stream flow during work on the Fens Bridge culvert. Temporary pumping of water around the structure during repairs likely will be required. Such disruptions should be short term in nature, while the repairs are progressing.

5.2.4 Resulting Flood Control

Flooding results from the inadequate cross sectional area of the channel caused by sedimentation and by undersized pipelines under the former Sears parking lot down to The Fens Bridge. Three project elements will provide flood control in the Back Bay Fens area: 1) dredging to provide adequate channel cross section, 2) replacing undersized piped sections, and 3) daylighting undersized piped sections.

During the design storm, the improvements would reduce the flood elevations by 1.1 feet at Ipswich Street and nearly 5.3 feet at The Riverway at the Sears Rotary. The improved conditions would eliminate roadway flooding along The Riverway during a storm similar to the October 1996 storm.

5.2.5 Construction Staging

Through the Back Bay Fens area, there are several staging areas planned for dredging at Agassiz Road (Agassiz Road Staging Area), adjacent to the Rose Garden (Lagoon Staging Area), and adjacent to the turnaround between The Fenway and Park Drive at the Avenue Louis Pasteur (Fens Staging Area). These staging areas are shown on Figures 2-27 and 2-28. The former Sears parking lot also will be used for equipment staging during culvert construction activities. At the Agassiz Road Staging Area, the travelway will be closed to general traffic and used as the staging area. The sidewalks along Agassiz Road will remain open to pedestrians. Only construction vehicles will be permitted to use Agassiz Road while it is in use as a staging area. At the other two staging areas in the Back Bay Fens area, all equipment will be staged off the travelway and there will be no temporary roadway, lane, or sidewalk closures. Although there are no sidewalk closures, there are several walking paths that must be temporarily closed. At the Lagoon Staging Area, there are two paths adjacent to the Rose Garden that must be closed. The path leading to the pedestrian bridge connecting Park Drive with The Fenway adjacent to the Rose Garden will remain open. At The Fens Staging Area, there are several internal walking paths between The Fenway and Park Drive that must be temporarily closed. These temporary path closures will not result in discontinued pedestrian flows - only redirected, detoured flows.

The first phase of construction will entail channel dredging and management of the dredged material. Dredging must begin first in order to use the available staging areas which would not all be available after the construction of the culvert and daylight facilities. Staging areas at Charlesgate, Agassiz Road, the Lagoon and upstream of Fens Bridge are the locations available for dredging and for dredge material management in the Back Bay Fens. Construction work from these staging areas will include dredging invasive species (such as *Phragmites*) removal, refilling shoreline areas and final regrading to historic shoreline configurations. Once the shorelines are returned to the historic configurations, replanting will take place to stabilize the disturbed areas. The staging areas at Charlesgate, and Agassiz Road also will be regraded in accordance with the final grading plan and replanted in accordance with the historic landscaping plan. The Fens Bridge and Lagoon staging areas will receive temporary stabilization consisting of regrading and hydroseeding to stabilize the area prior to use in the construction of the daylighting and culvert facilities. It is anticipated that the dredging operations and use of these staging areas will be about 14 months in duration.

Construction of culverts and daylighting will likely require using some of the same staging areas as the dredging operations. For those operations that will utilize dredging staging areas, the dredging operations must be completed first. The Fens Bridge and Sears parking lot areas will be used during the construction of the culverts and daylighting sections. The Lagoon staging area also may be required by the contractor for staging offices and equipment necessary for the construction of the culverts and daylighted sections. The former MDC Kelly Rink area also is suitable for truck staging in the dredging or culvert/daylighting operations.

Actual construction staging will depend on the logical sequence of construction necessary to complete this work. The contractor will submit a construction sequence for work in the culvert and daylighting areas based on a proposed construction methodology. It is anticipated that the sequence will entail constructing the culvert sections first using the areas to be daylighted as staging sites. Once the culverts are completed, the daylighting can take place. At the two new arch culvert sections construction will proceed in a segmented open cut approach keeping the full number of roadway lanes open during construction.

After the construction of the culverts and daylighting is completed the area will be rehabilitated with historic landscape planting and new pedestrian and bike pathways. The staging areas at the Sears Lot and Fens Bridge will no longer be present once this construction is complete. The staging area at the Lagoon if used during construction of the culverts and daylighting can then be regraded and landscaped. It is anticipated that the construction period of the culverts and daylighting will use the staging areas for about 18 to 24 months.

5.2.6 Traffic Management for Construction

Various alternative truck routes to/from the Agassiz Road, Lagoon, and Fens Staging Areas were proposed and presented to the Citizens' Advisory Committee and to representatives from the Boston Transportation Department, the MDC, and the Town of Brookline. From the various possible truck routes that were discussed and proposed, the preferred routes were selected. For the Agassiz Road, Lagoon, and Fens Staging Areas, I-93 is the preferred regional route based on ease of access/egress. Using Route 9 or I-90 to access these staging areas would result in circuitous traffic patterns along roadways through neighborhoods that are not appropriate for truck traffic. From I-93 (Exit 18), the recommended access route follows Melnea Cass Boulevard, Tremont Street, Ruggles Street, Louis Prang Street, Boylston Street, and Park Drive. For the Lagoon and Fens staging areas, the egress route is essentially the reverse of the access route. For the Agassiz Road staging area, trucks enter from Park Drive and exit to The Fenway, travelling Westland Avenue to Massachusetts Avenue to I-93. This Agassiz Road egress route by way of Massachusetts Avenue minimizes the construction traffic that uses the Sears Rotary. Figure 5- 10 indicates the point of access/egress off Park Drive/The Fenway to these staging areas. Figure 5-3 presents the project-wide truck routes for each staging area.

The use of Agassiz Road as a staging area will require temporary closing of the road to general traffic while the staging area is active. Agassiz Road is a one-way eastbound link between Park Drive and The Fenway. Figure 5-11 presents the road closure plan, with the potential traffic diversions that are expected to occur. Detours through the Sears Rotary may occur. However, the Jersey Street to Boylston Street detour is less circuitous. Traffic demands along Agassiz Road are relatively low - only 1,400 vehicles per day during a typical weekday use Agassiz Road. Pedestrian access, however, will be maintained along Agassiz Road between Park Drive and The Fenway during construction.

In addition to traffic management to the staging areas, an implementation plan is needed to maintain and manage traffic during the culvert replacement through the Sears rotary. Two culverts are being replaced: (1) across The Riverway; and (2) across Brookline Avenue. The Sears rotary serves heavy traffic demands during the day. Traffic management alternatives during culvert replacement have been carefully studied. Figure 5-9 provides a summary of the proposed culvert replacement implementation plan. A more detailed traffic assessment is provided in Section 6.

The culvert construction across The Riverway could be completed during the day in phases without excessive traffic disruptions. This is because of the pavement widths and generally flat grades adjacent to the travelway which allow for temporary lane construction, coupled with the fact that traffic demands on this portion of the rotary are lower than the demands along Brookline Avenue. This would involve no more than one lane closure at a time with minor signal timing adjustments.

Completing the culvert replacement across Brookline Avenue during the day given heavy traffic demands along Brookline Avenue would be very difficult. The link of

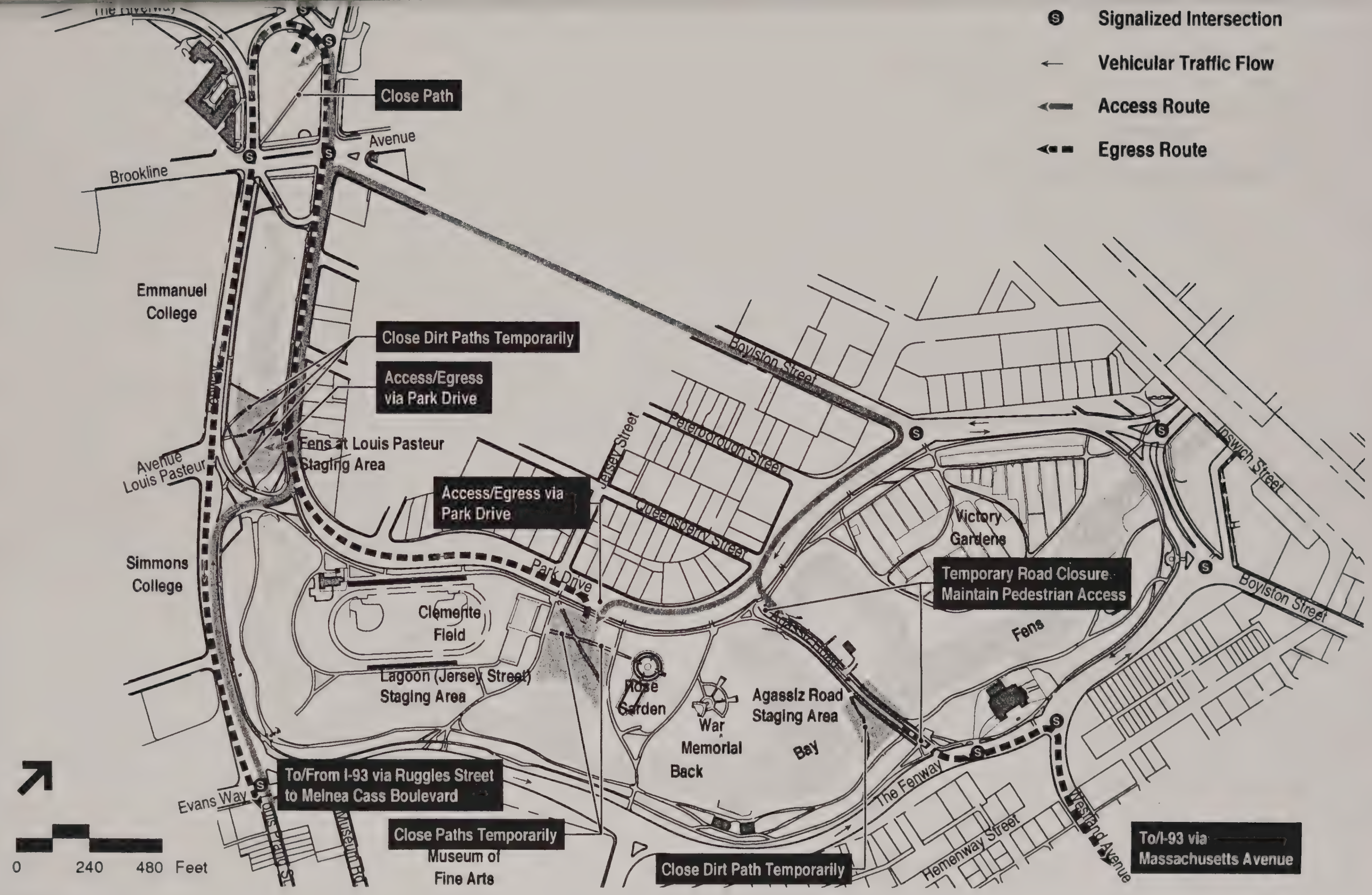

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Figure 5-10

Back Bay Fens Area Potential Staging Area Access/Egress Plan for Construction Traffic

Source: VHB, Inc.

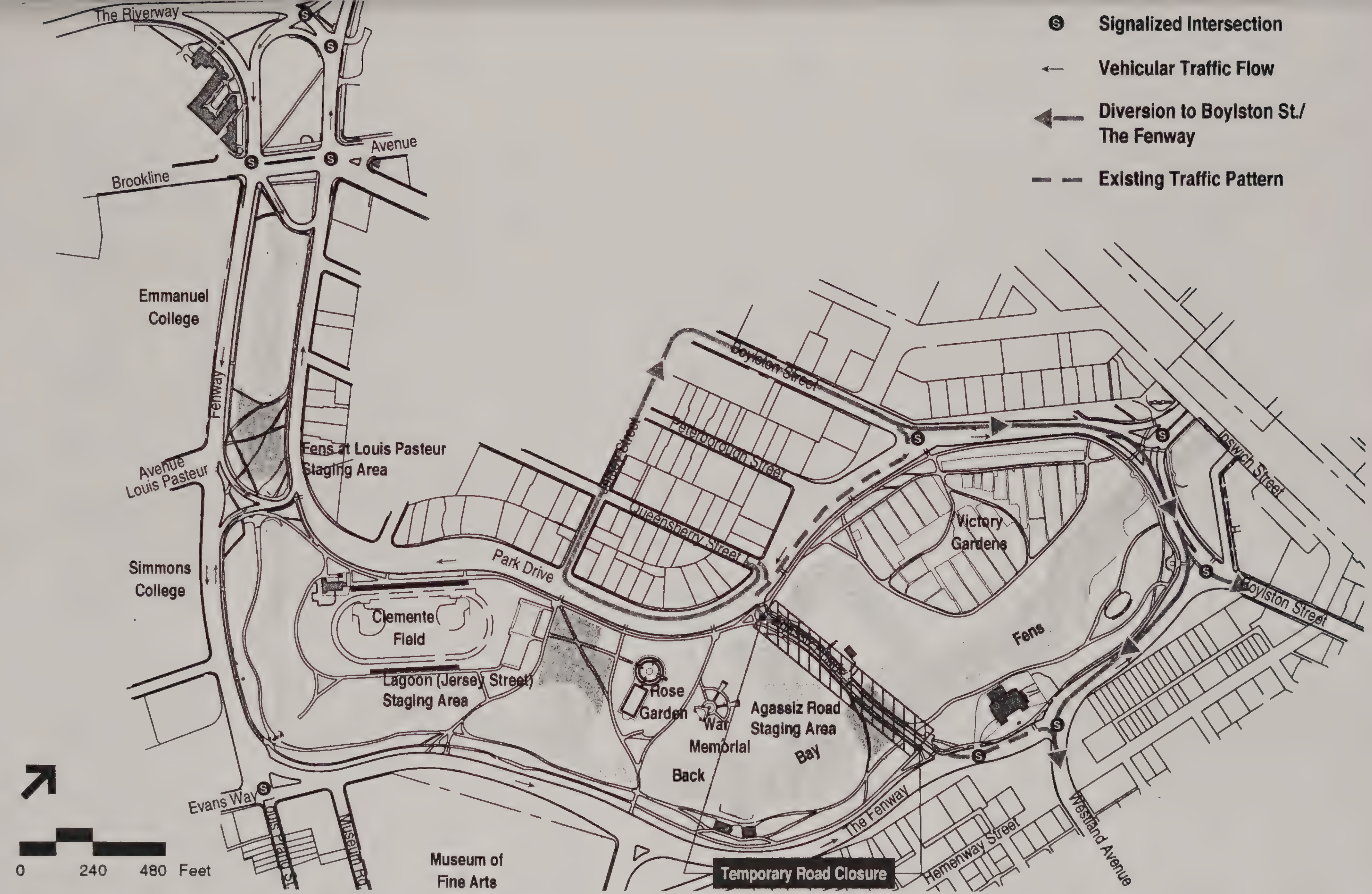

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Figure 5-11
Back Bay Fens Area Agassiz Road Traffic Diversions for General Traffic

Source: VHB, Inc.

Brookline Avenue between Park Drive and The Fenway is congested during the day resulting in operational issues at the adjacent intersections - especially at the Boylston Street/Park Drive intersection. Based on an analysis of peak hour conditions at the rotary, even a one-lane closure along Brookline Avenue would significantly exacerbate the existing congestion.

There is sufficient area on either side of Brookline Avenue in the former Sears parking lot and toward the jug handle to construct lanes so as not to shut down any lanes during daytime construction. However, the traffic turning movements and detours into the altered lanes would likely cause significant additional traffic back up if construction occurred only in the daytime. A cursory review of a possible construction schedule indicates that a daytime only construction period would be at least 6 months longer than one which includes nighttime work.

Alternatives to daytime construction would be all nighttime work or a combination of daytime and nighttime work. A nighttime work schedule when traffic demands along Brookline Avenue are significantly lower should be considered. By doing so, more aggressive lane closures and diversions can be implemented. For example, the U-turn between The Fenway and Park Drive can be closed at night while construction occurs across the travelway (Phase 1 on Figure 5-9). Brookline Avenue eastbound traffic can be diverted to the U-turn while construction is focused on Brookline Avenue (Phase 2). The westbound side of Brookline Avenue is relatively flat, allowing for the construction of temporary lanes when construction shifts to the westbound side of Brookline Avenue (Phase 3).

The heavy traffic demands present during the daytime also may occur during special events in the area, such as Red Sox games, "moving days" and commencement exercises. Construction activities would need to be coordinated during such periods of high demand.

Nighttime construction may potentially cause negative noise and disturbance impacts to residents who reside near the construction site. A combination schedule would allow construction outside of Brookline Avenue to occur during the day and the actual crossing during the nighttime. In order to limit noise and maintain traffic lanes, several construction alternatives are proposed. An early construction activity would involve installing foundation piles and sheeting along the trench sides. Using drilled piles and vibratory sheeting between 7 and 11 PM would minimize noise impacts on nearby residents. No drilling or sheet piling would be conducted after 11 PM.

In order to open and close lanes for nighttime construction, a temporary, removable bridging slab would be constructed that would span the excavation during the daytime. The slab would be removed by crane before night work begins and replaced before the next morning rush hour. Utilizing these techniques, a construction period would potentially be six months shorter than daytime construction with less impact on traffic, although it would result in some nighttime noise impact.

To reiterate, the existing traffic demands at The Riverway/The Fenway/Park Drive intersection are such that a one-lane closure across The Fenway and The Riverway is possible provided that signal-timing adjustments are made. However, anything more than a one-lane closure will have significant traffic impacts along Brookline Avenue that cannot be mitigated with signal timing adjustments. These diversions and temporary lane closures at the rotary will result in the need to adjust signal timing and phasing at several intersections through the rotary to ensure that the existing signal coordination through the rotary is not compromised. Section 6.2.4 provides more detail on these traffic impacts.

In addition to staging area and culvert construction-related traffic, contractor truck trips and equipment mobilization associated with *Phragmites* removal, landscaping and other miscellaneous activities will occur.

5.2.7 Landscape and Historic Resources

The existing site has historical resources with integrity from both the Primary and Secondary Periods of Significance, but the Secondary Period has the greater resources extant. Documentation of this area will provide the needed information to restore the shoreline after dredging and removal of invasive plant material from the banks and to identify the extant features. Planting plans and plant lists are scant from the Primary Period and have not been found for the Secondary Period. Since The Fens currently is freshwater, we will utilize the plant lists for the Muddy River for Olmsted Park and The Riverway. When plants are selected from the Olmsted lists factors such as height, color, texture, appropriateness for location, habitat value, maintainability and whether they are now considered invasive will all be taken into consideration. Concerning vegetation and landscape effect for Back Bay Fens, there is a short descriptive passage from one of Olmsted's reports that makes a clear connection between the Muddy River scenery and what he intended for the part of the Fens not subject to flooding that can aid us in our treatment.

"The right bank of Muddy River, on the reach below Longwood Avenue bridge, illustrates the character of the slopes and plantations, which I should think well to have in view in forming the margin of the basin…" Frederick Law Olmsted to Boston Park Commissioners in Board of Commissioners of the Department of Parks of the City of Boston, Fifth Annual Report for the Year 1879, City document 15-1879 (Boston 1880), p.12.

Treatment at Back Bay Fens will include the following:

- After dredging is complete, the original shoreline will be rehabilitated to the Secondary Period of Significance for areas that were filled during the Shurtleff Period and will be preserved in areas that were not filled or modified by Shurtleff and therefore, still represent the shoreline extant from the Primary Period. Stabilization of banks after dredging will include plant massing to reflect the Primary and Secondary Periods of Significance. Planting will include wetland planting, bank planting and upland planting of both shrub and tree layers to restore the historic designed landscape and to improve biodiversity for wildlife habitat. See Figure 5- 12 and Preliminary Design Plans L-6 and L-23 in Appendix I.

- Rehabilitation of the landscape, after removal and dredging of invasive materials on banks and over water, such as *Phragmites* and Purple Loosestrife, will include both plant massing and the construction of turf covered bank to reflect both the Primary and Secondary Periods of Significance. Planting will include wetland planting along both planted and turf banks, bank planting and upland planting of both shrub and tree layers to improve wildlife habitat and to restore the landscape historically. Turf covered banks will include a wetland edge to improve and restore historic designed landscape, to improve biodiversity for wildlife habitat, and to restore the original historic designed viewsheds. The wetland plants selected will vary in height and at turf banks will be high and dense enough to act as a deterrent to water fowl while still allowing for important views of the water. See Figure 5-13.

- The rehabilitation planting not only addresses the historic rehabilitation aspects of the project but also addresses Wetlands Protection Act and habitat value. The proposed planting in Resource Areas under the Wetlands Protection Act will take into consideration species that will support the functioning of the resource areas, particularly Bordering Vegetated Wetland, Bank and Land Underwater. These plantings will be selected from the Olmsted list representing a diverse mix of species and selected for their habitat value. In this way, the rehabilitation is expected to meet historic, wetland and habitat considerations.

- After completion of the dredging, the staging area at the Agassiz Road site will be rehabilitated. At Agassiz Road existing trees that will remain will be protected and pruned. Some trees will be removed and replaced in kind, existing paths and sidewalks will be rehabilitated, and existing lawn areas will be restored. An existing desire line path, which has resulted in erosion of lawn areas, will be regraded and constructed as a new path to incorporate BMP's. The original Agassiz Road was a two-way road prior to the MDC design to one-way with a narrowed roadway and expanded lawn edges. To respect the continuum, the road will remain one-way with its current narrowed roadway.

- In the staging areas to be rehabilitated and other portions of the park disturbed by contractor's operations, rehabilitation will include aeration and soil condition in accordance with standard horticultural practice. Any areas that have been compacted by the contractor's operations will receive the aeration and soil conditioning treatment. This practice also applies to other rehabilitation areas described in the following bullets.

- After daylighting to increase flood storage capacity between The Fenway and Brookline Avenue at the former Sears parking lot, the area will be rehabilitated to reflect the Primary Period of Significance. Complete grading plans, plant massing, view plans, and planting plans will allow for the restoration of much of the banks

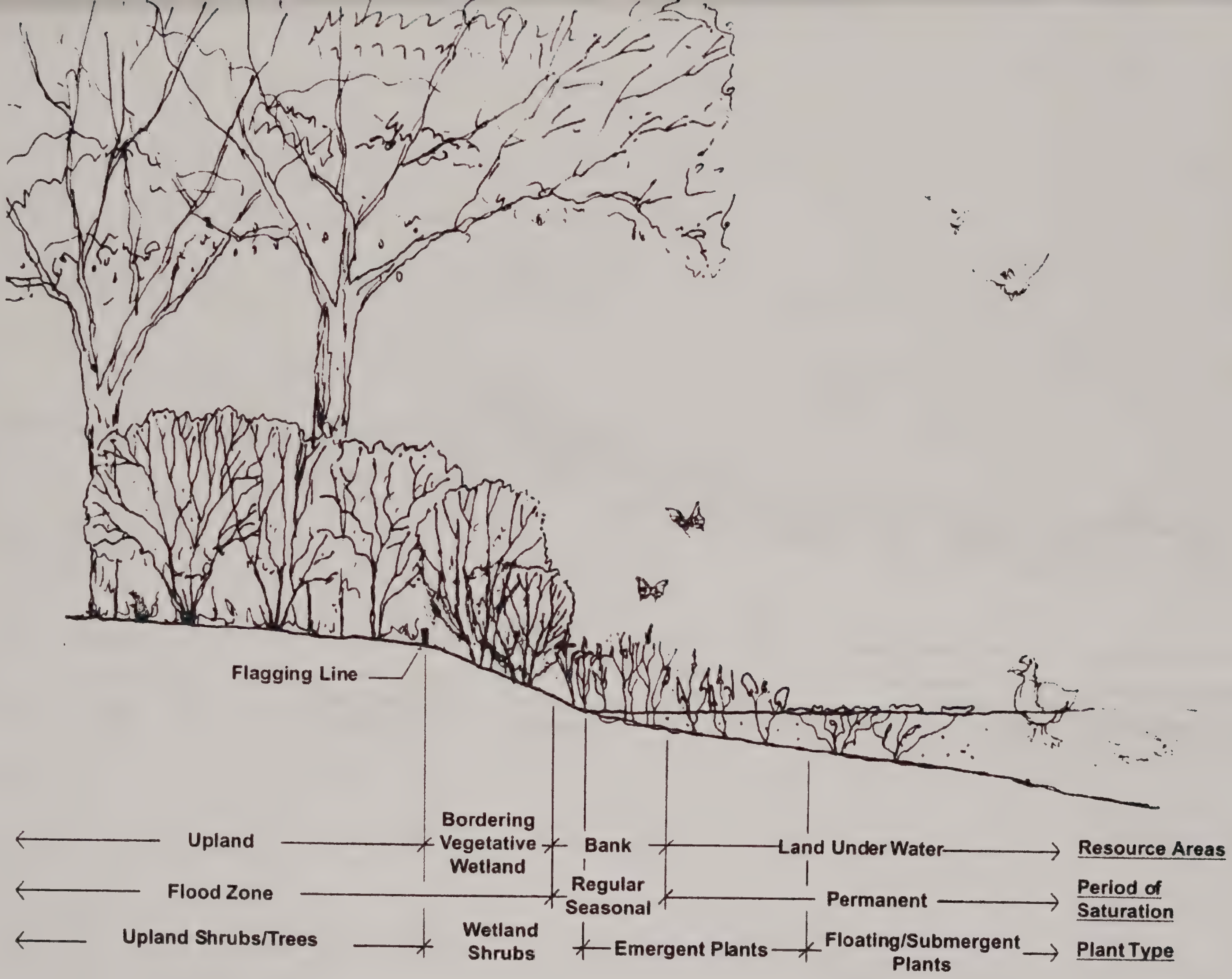

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Figure 5-12
Typical Healthy Ecosystem Cross Section

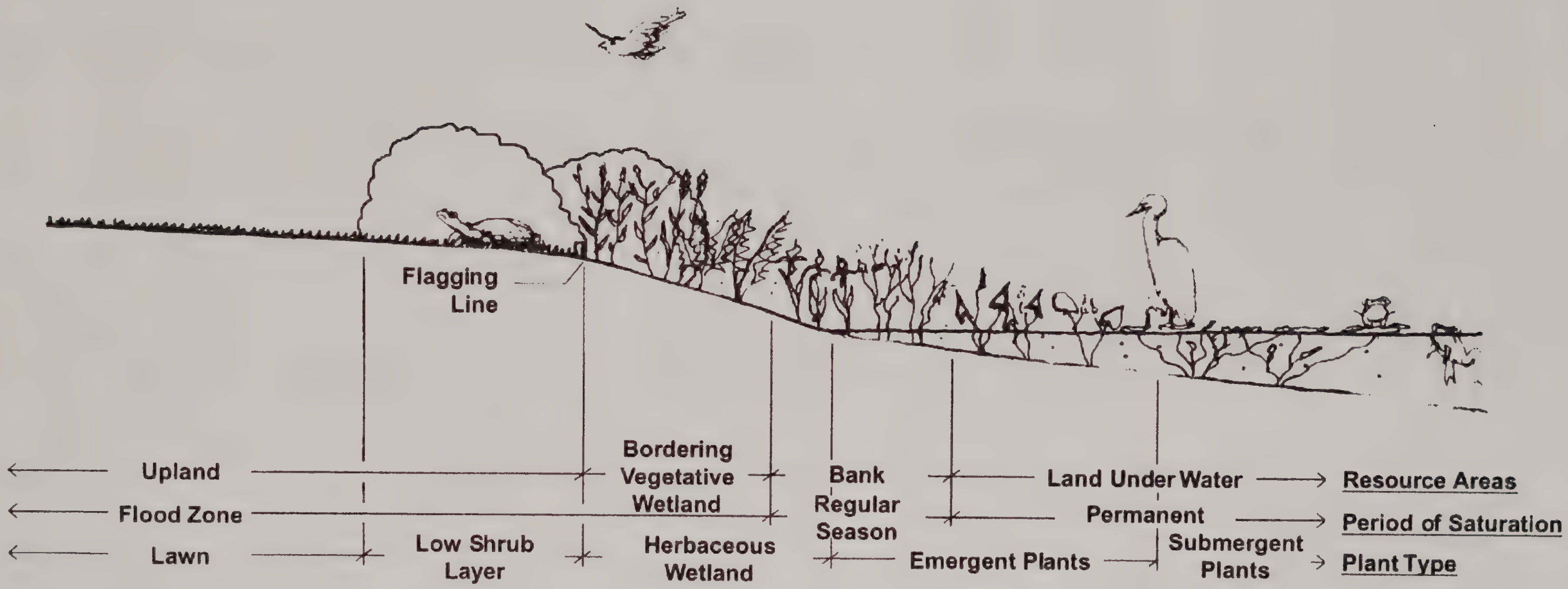


Figure 5-13
Typical Healthy Olmsted Turf Covered Bank Section

and original shoreline of the Primary Period. The new culvert headwall at Brookline Avenue and the new culvert headwalls on the south and north sides of the Sears at The Fenway will be completed with planting restoration. Rehabilitation of the pedestrian and equestrian path system will be designed taking into consideration the removal of the historic bridge along with land takings by the MDC to accommodate widening of the roads, and the current pedestrian and bicycle circulation and crosswalks. The actual area of park was reduced significantly for road takings and the removal of the bridge ended canoe access up the Muddy River from this point. Planting, lawn, path design and crosswalk design will be included.

- After completion of the dredging, the staging area at the Lagoon area will be rehabilitated. Existing trees that will remain will be protected and pruned. Existing trees and paths will be removed within the staging area, if necessary, and the area will be planted and paths constructed to restore the site to the Secondary Period of Significance. The 1926 Shurtleff Master Plan for this segment was a lawn area with extensive shrub planting, two east/west paths to two footbridges and a north/south cross path. The lagoon was a reflecting pool for the Museum of Fine Arts. The goal is to rehabilitate this area to reflect the Secondary Period of Significance.

- Under the issue of BMP's, several areas along The Fenway will be rehabilitated and paths and drainage patterns will be redesigned to prevent the siltation resulting from human disturbance and water runoff from the surrounding roadways. As an example, desire line paths from and to the Museum of Fine Arts need to be accommodated or redirected or controlled utilizing plantings. Rehabilitation will include lawns, plantings and pathways.

- After daylighting to increase flood flow capacity between The Fens Bridge and Brookline Avenue, the area will be rehabilitated to reflect the Primary Period of Significance. Complete grading plans for this area and plant massings as shown on the 1921 Survey will allow for the restoration of the banks and the original island from the Primary Period. The island and the banks will be reconstructed to reflect these historic massings and to accommodate wildlife. The island will not be accessible to the public, thus providing safe wildlife habitat. (See Figure 5-14.) The new culvert headwall at Brookline Avenue, the reconstruction of The Fens Bridge culvert headwall on the south side and the restoration of the north side culvert headwall at The Fens Bridge will be completed with

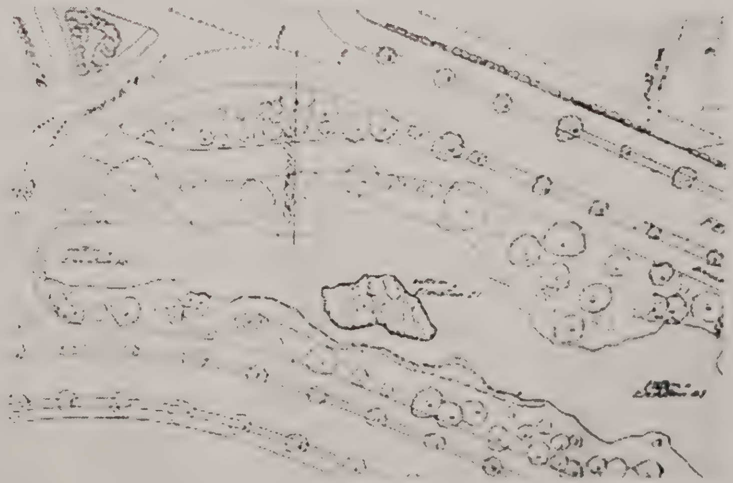


Figure 5-14
Back Bay Fens Survey (July 1921), with Historic Island
Sheet 8 of 8, Arthur A. Shurtleff
Source: BPRD

planting rehabilitation to reflect the Primary Period of Significance. Rehabilitation of the pedestrian and equestrian path system will be designed taking into consideration the land takings by the MDC to accommodate widening of the roads, development of a turn by the MDC at Brookline Avenue, current circulation and crosswalks, and to restore the historic designed landform. Planting, lawn and path design will be included.

Replanting in staging areas and other disturbed areas will be dependent on the schedule of the work and optimum planting seasons. As dredging and bank stabilization work is completed, the contractor will be expected to provide temporary erosion control measures and then provide landscaping during the next planting season (generally spring and fall). The staging areas are expected to be the last areas vacated by the contractor, so they will be rehabilitated and replanted once the contractor removes equipment from the staging area at the completion of the work. Temporary erosion control measures will be used in the staging areas until the next planting season when vegetation is replanted.

In all replanted areas, the contractor will begin a two year guarantee and maintenance period once provisional acceptance is made of the planted material.

Refer to Preliminary Design Plans L-6 to L-23 included in Appendix I showing proposed treatment in Back Bay Fens.

5.3 Riverway

Construction activities that are proposed within The Riverway area (defined as The Riverway Road at the former Sears parking lot to Leverett Pond) include:

- The formation of one staging area for sediment dewatering equipment and the loading of sediment into trucks;
- The improvement of the flood carrying capacity via the dredging and removal of approximately 20,200 cy of accumulated sediment and debris;
- The preservation of the historic park shoreline through the removal of approximately 10,000 cy of invasive species and the restoration of the natural bank;
- The preservation of the historic park features by the revegetation of the new bank, and the establishment of wetland areas and masses of upland vegetation plantings;
- Revegetation of the staging areas upon completion of the work;
- The repair or replacement of worn pathways and denuded ground; and
- Rehabilitate historic islands.

Project objectives met by the above construction activities are summarized on Table 5-3. Five of the activities address three or more of the project objectives.

TABLE 5-3
PROJECT OBJECTIVES MET BY RIVERWAY AREA PROJECT ELEMENTS

	PROVIDE FLOOD CONTROL	*IMPROVE WATER QUALITY*	*ENHANCE AQUATIC & RIPARIAN HABITAT*	*REHABILITATE LANDSCAPE & HISTORIC RESOURCES*	*INSTITUTE BEST MANAGEMENT PRACTICES*
Dredge approximately 20,200 CY of sediment	None	Removing sediments will improve water quality in river segment	Removing sediments will improve bottom habitat and improve water quality	Restores historic capacity and shape of river channel	None
Remove approximately 10,000 CY of invasive species and restore bank	Prevents future encroachment into floodway that would reduce flood capacity	None	Results in more diverse aquatic and riparian habitat	Removes invasive plant material from historic landscape	None
Re-vegetate disturbed bank areas and establish wetland areas	None	Reduces erosion from unvegetated areas	Results in more diverse aquatic and riparian habitat	Rehabilitates landscape treatment from Olmsted plant list	Reduces erosion from unvegetated areas
Re-vegetate disturbed construction areas including staging areas	None	Reduces erosion from unvegetated areas	Results in more diverse aquatic and riparian habitat	Rehabilitates landscape treatment from Olmsted plant list	Reduces erosion from unvegetated areas
Repair / replace pathways and re-vegetate desire lines and unplanted areas	None	Reduces erosion from unvegetated areas	Results in more diverse aquatic and riparian habitat	Rehabilitates landscape treatment from Olmsted plant list	Reduces erosion from unvegetated areas
Rehabilitation of historic islands	None	Reduces erosion from unvegetated areas	Results in more diverse aquatic and riparian habitat	Rehabilitates landscape treatment from Olmsted plant list	Reduces erosion from unvegetated areas

5.3.1 Channel Dredging and Dredge Material Management

River cross-sections along The Riverway from the former Sears parking lot up to Leverett Pond have been reduced due to sediment deposition. While the reduction is not sufficient to be the cause of additional flooding, the historic capacity of the channel has been reduced. Restoration of the former cross sections returns these watercourses to their historic capacity and also increases the volume of the water bodies thereby increasing the amount of aquatic habitat available. Dredging also removes sediment that can be moved downstream, since the improved flood flows will create higher stream velocities. Downstream improvements will result in lower flood elevations in The Riverway.

Dredging and dredge material management discussed in the following sections will be accomplished similar to the dredge programs discussed in Section 5.1 and 5.2 using hydraulic dredging and dewatering using belt presses.

A primary goal of restoring the channel cross section in The Riverway section of the Muddy River is minimize downstream deposition of the sediments from The Riverway section. During the design storm flow velocities in The Riverway vary between 0.2 and 4.2 feet per second (fps). A plot of the velocities during the design storm is shown on Figure 5-15. At velocities greater that about 1.0 fps unconsolidated sediments are moved along the river bottom. After improvements are implemented downstream of The Riverway, velocities are expected to increase to between 0.4 abd 5.5 fps. The increase is due to the higher downstream capacity that will pass larger storm flows more quickly. By removing sediments to the original channel depths, less sediment can be moved and deposited in downstream dredged areas.

Dredging in The Riverway will lower the invert of the stream from between 4 ft. and 6 ft. to a new elevation that varies from 4.1 ft. BCB below Route 9 to 3.21 ft. BCB at The Riverway culvert near the former Sears parking lot. Typical cross sections along The Riverway are shown on Figure 5-16.

Dredging in The Riverway area will be conducted using hydraulic dredging equipment and dewatering as discussed in Section 5.1.1. One staging area will be used for the dredging between the former Sears parking lot upstream to Brookline Avenue. One staging area at Netherlands Road is proposed for dewatering equipment in this area. All sediments will be pumped to the staging area using flexible piping laid in the riverbed.

Closing Netherlands Road between Parkway Drive and The Riverway will create the Netherlands Road staging area. During construction the contractor will be required to maintain a temporary pedestrian pathway along one side of the site. Access to the river on either side of Netherlands Road adjacent The Riverway can be provided with minimal loss of existing trees (2 to 3). The area to the river will be replaced with historic wetland and emergent plantings once dredging and invasive species removal is completed.

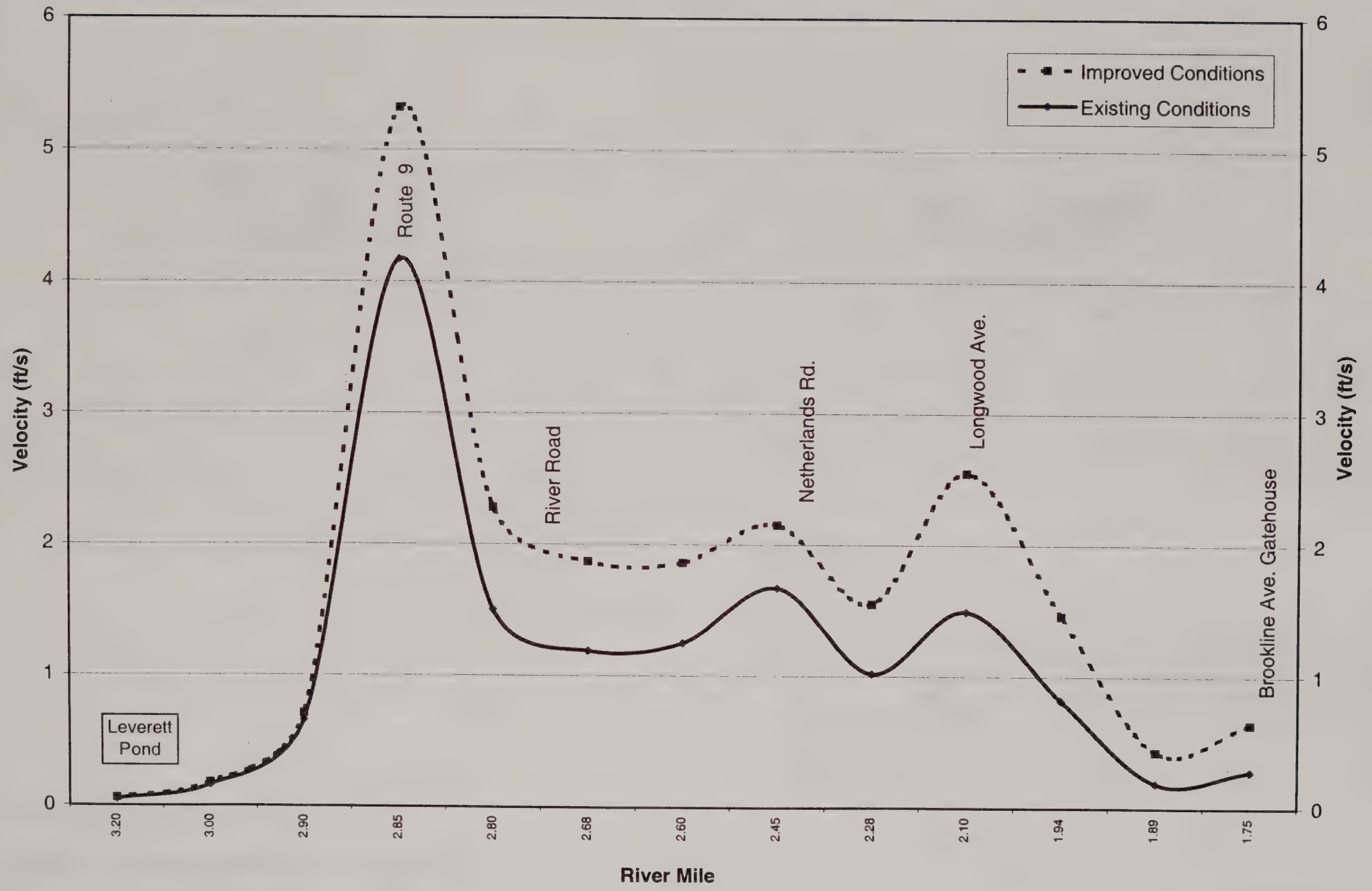
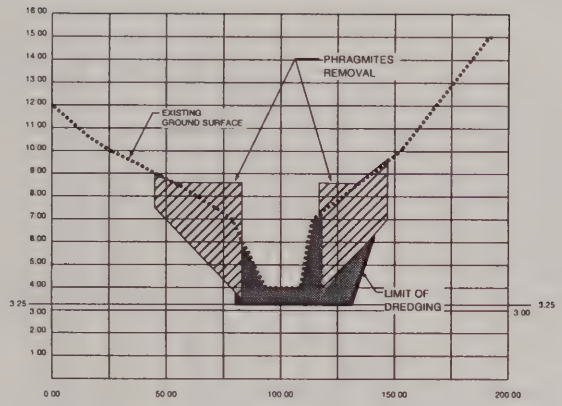
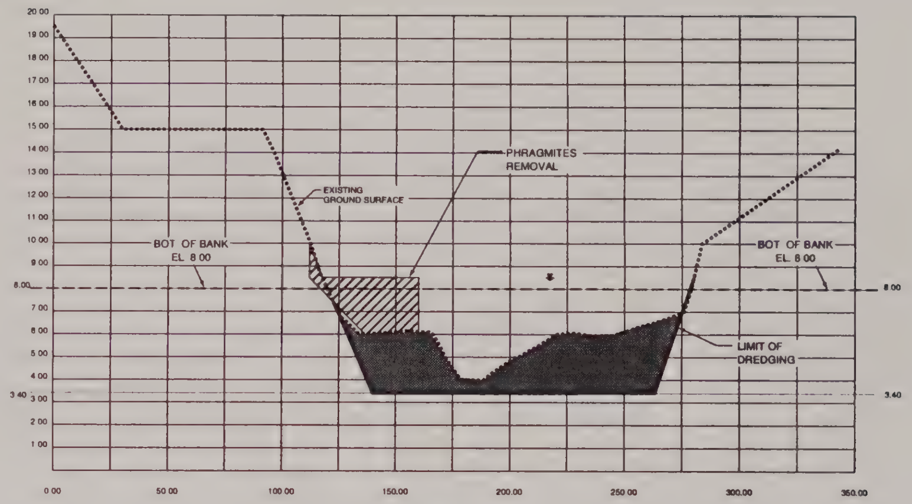


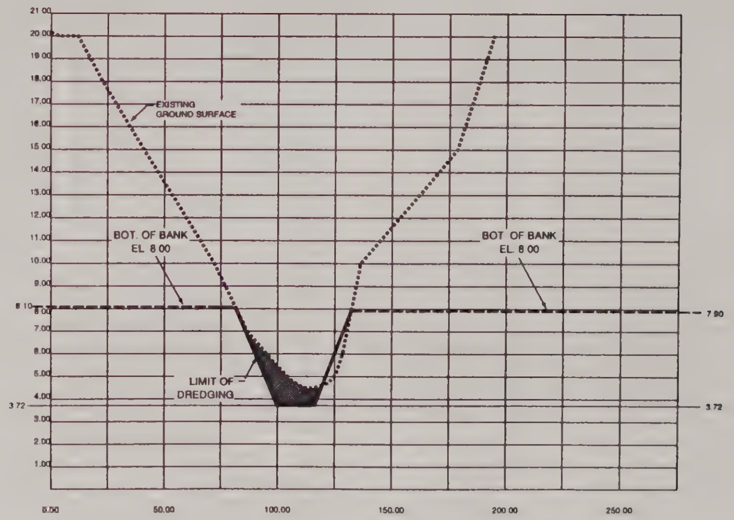
Figure 5-15
Simulated Velocities in the Riverway Section of the Muddy River
October 1996 Storm



SECTION 16
AT STATION 91+00



SECTION 18
AT STATION 101+20



SECTION 22
AT STATION 121+20

Boston City Base Datum (BCB)

Location of Cross Sections Shown on Figure 5-16

CDM Camp Dresser & McKee Inc.

Figure 5-16
Cross Sections of Riverway Dredging

Sediment along The Riverway varies in quality as discussed in Chapter 4. Disposal of the sediments will be consistent with the figures in Appendix F. Approximately 12,600 cubic yards of the material will be disposed at an out-of-state landfill. About 7,600 cy of these sediments are sufficiently clean to be disposed of in an in-state landfill, however their physical characteristics (amount of fine materials and water content) appear to warrant out-of-state landfill disposal.

Shore areas disturbed by sediment dredging or invasive species removal will be reshaped to the historic shoreline and will include a shelf for planting wetland emergent species.

5.3.2 Invasive Species Removal

Invasive species (*Phragmites*) will be removed using mechanical means in The Riverway area. The contractor's means and methods will be restricted to avoid unnecessary disturbance to Bank and BVW. The *Phragmites* will be removed using backhoe equipment mounted on barges from the water, a low-impact excavator that could support itself on the root mat or other equivalent methods. Stalks of the *Phragmites* will be cut by hand first and removed by barge to the staging areas. The *Phragmites* roots will be excavated using a backhoe and the material will be removed through the staging areas. Once the *Phragmites* roots are removed, any disturbed shore areas will be refilled and reshaped to the historic shoreline. This will allow a shelf to be reestablished for wetland planting along the waters edge. The areas of *Phragmites* removal are shown on Figures 5-17 and 5-18. In the very narrow segments of The Riverway upstream of Netherlands Road, there may be a need to remove some material with an excavator on land due to narrow conditions.

Closing Netherlands Road between Parkway Drive and The Riverway will create the Netherlands Road staging area. During construction the contractor will be required to maintain a temporary pedestrian pathway along one side of the site. Access to the river on either side of Netherlands Road adjacent The Riverway can be provided with minimal loss of existing trees. The area near the river will be replanted with historic wetland and emergent plantings once dredging and *Phragmites* removal is completed (see Section 5.3.5).

5.3.3 Construction Staging

In The Riverway area, Netherlands Road is proposed to be closed to general traffic and the existing travelway will be used for construction equipment staging. The closure of Netherlands Road to general traffic will result in diversions to The Riverway and Brookline Avenue. Section 5.3.4 details the traffic flows that are expected to be diverted.

5.3.4 Traffic Management for Construction

Various alternative truck routes to/from the Netherlands Road Staging Area were proposed and presented to the Citizens' Advisory Committee and to representatives

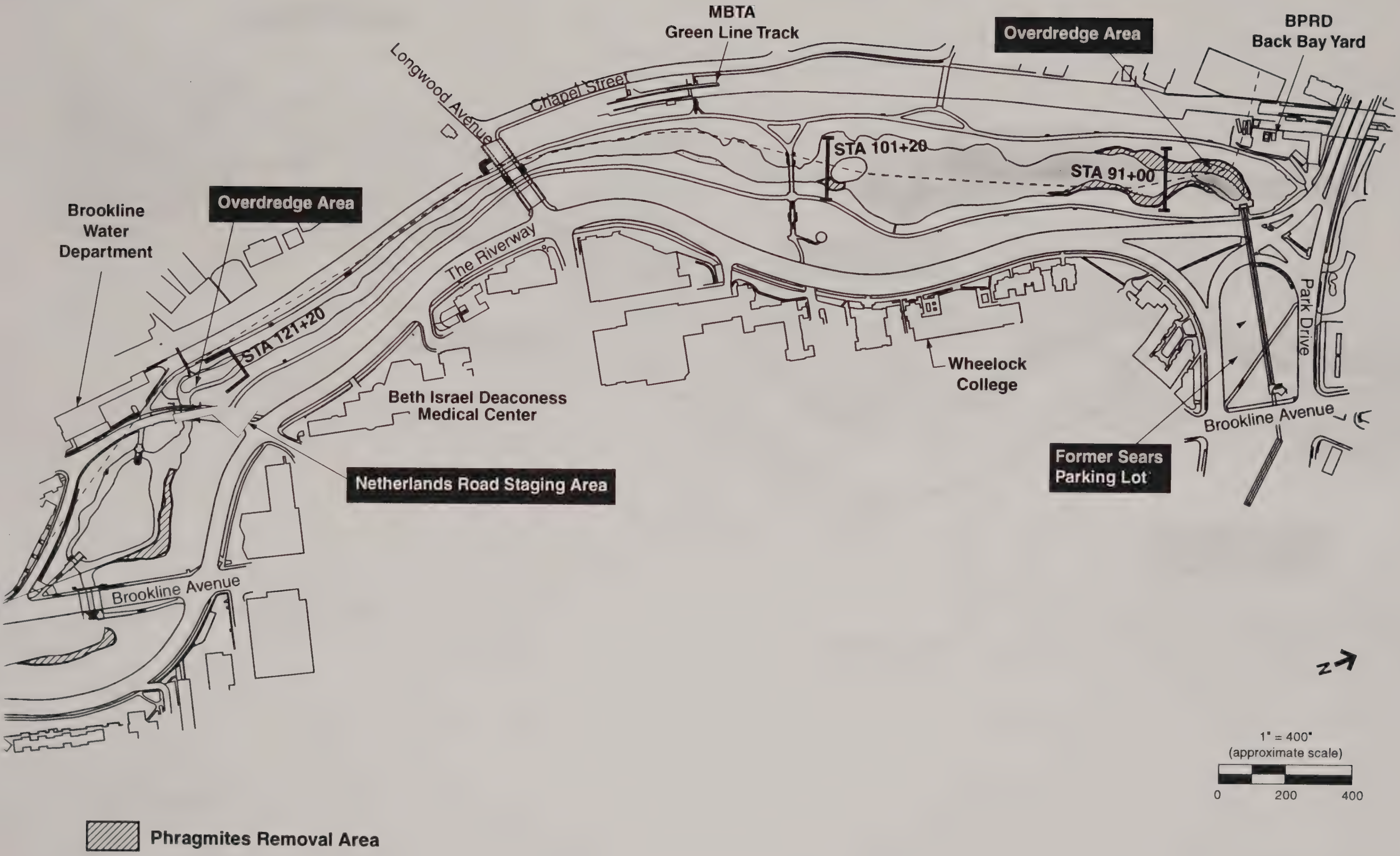


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Figure 5-17
Phragmites Removal Area in Riverway North

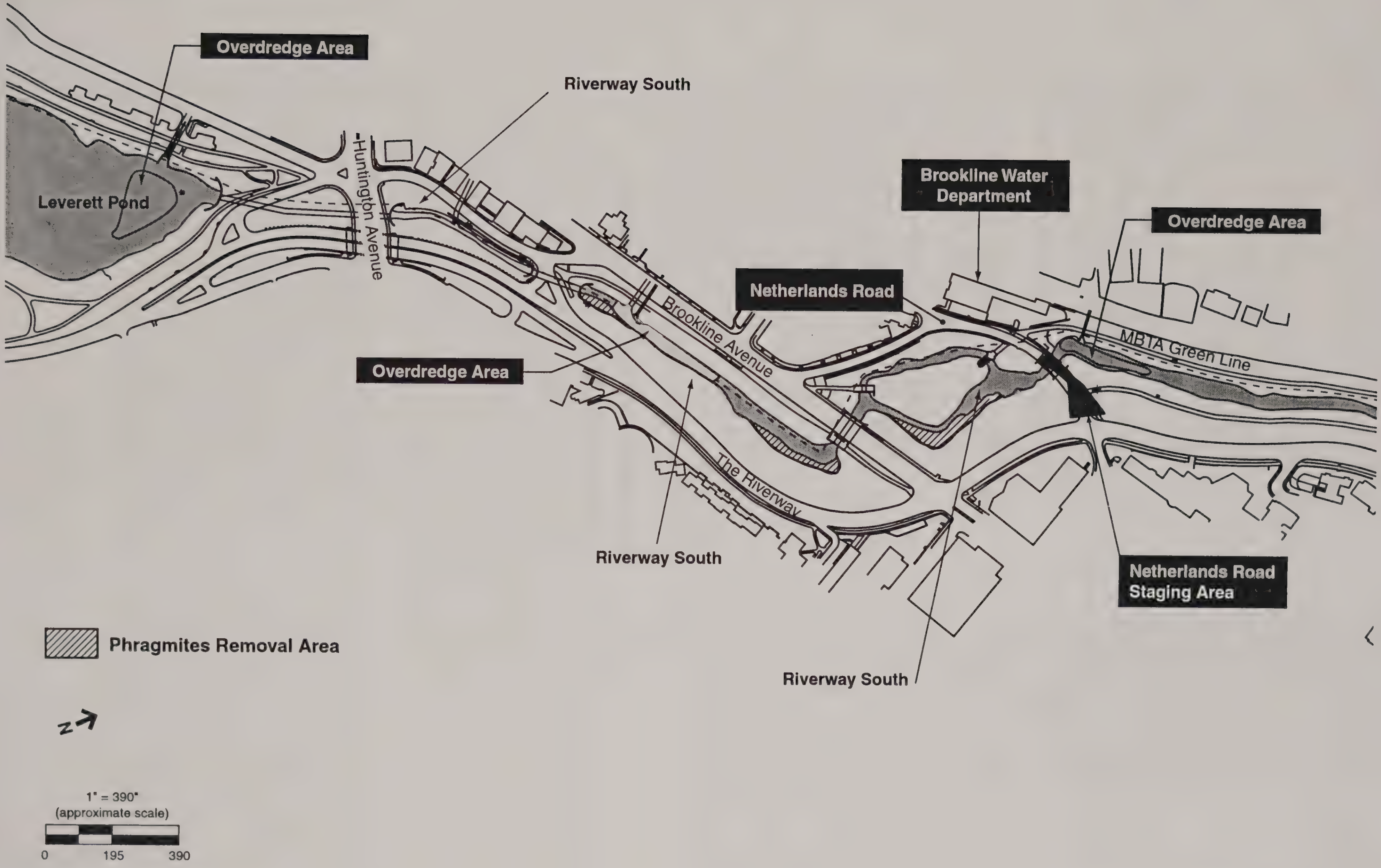

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Figure 5-18
Phragmites Removal in Riverway South

from the Boston Transportation Department, the MDC, and the Town of Brookline. For the Netherlands Road Staging Area, Route 9 is the preferred regional route based on ease of access/egress. Using I-93 or I-90 to access this staging area would result in circuitous traffic patterns along roadways through neighborhoods that are not appropriate for truck traffic. From Route 9, the recommended access route follows Brookline Avenue to Aspinwall Avenue to Netherlands Road. Leaving the staging area, the recommended truck route follows a short segment of The Riverway from Netherlands Road to Brookline Avenue, and then from Brookline Avenue to Route 9. Figure 5-19 indicates the point of access/egress for construction traffic at the Netherlands Road Staging Area. Project-wide truck routes are shown on Figure 5-3.

The use of Netherlands Road as a staging area will require closing the roadway to general traffic. Figure 5- 20 presents the road closure plan, with the potential traffic diversions that are expected to occur. Traffic entering Netherlands Road via The Riverway is predominantly cut-through traffic bypassing the signal at The Riverway and Brookline Avenue. Vehicles using Netherlands Road as a bypass would be forced to pass through the intersection of The Riverway at Brookline Avenue, making a right-turn onto Brookline Avenue. Heading toward The Riverway, motorists using Netherlands Road would have to proceed to the intersection of The Riverway at Brookline Avenue and turn left onto The Riverway. Although the elimination of traffic bypassing The Riverway/Brookline Avenue intersection via Netherlands Road is a positive measure for residents of this area, the added traffic at this already congested intersection will have a negative effect in terms of traffic operations. Section 6.3.4 provides a more detailed assessment of these impacts.

5.3.5 Landscape and Historic Resources

Two types of project elements have affected treatment for landscape and historic resources, as discussed in this section. Dredging elements in the Riverway will affect historic resources because the justification for dredging in this area is related more closely to returning the resource to its historic shape and form than to strictly providing flood control or water quality benefits. This is not to say that benefits to water quality and flooding do not accrue with dredging. Rather, they are not the principal reasons for dredging in these areas. The dredging elements are discussed in Section 5.3.1, but they also have a significant historic element.

The existing site has extant historical resources with integrity from the Primary Period of Significance. Documentation of this area will provide the needed information to restore the shoreline after dredging and removal of invasive plant material from the banks and to identify and protect the extant features. Planting plans, grading plans, viewshed design and plant lists are complete for the Primary Period and will provide the information needed to rehabilitate the areas disturbed during this part of the project and to recover the landscape effect that Olmsted intended and that is documented in historic photographs. When plants are selected from the Olmsted lists factors such as height, color, texture, appropriateness for location, habitat value, maintainability and whether they are now considered invasive will all be taken into consideration.

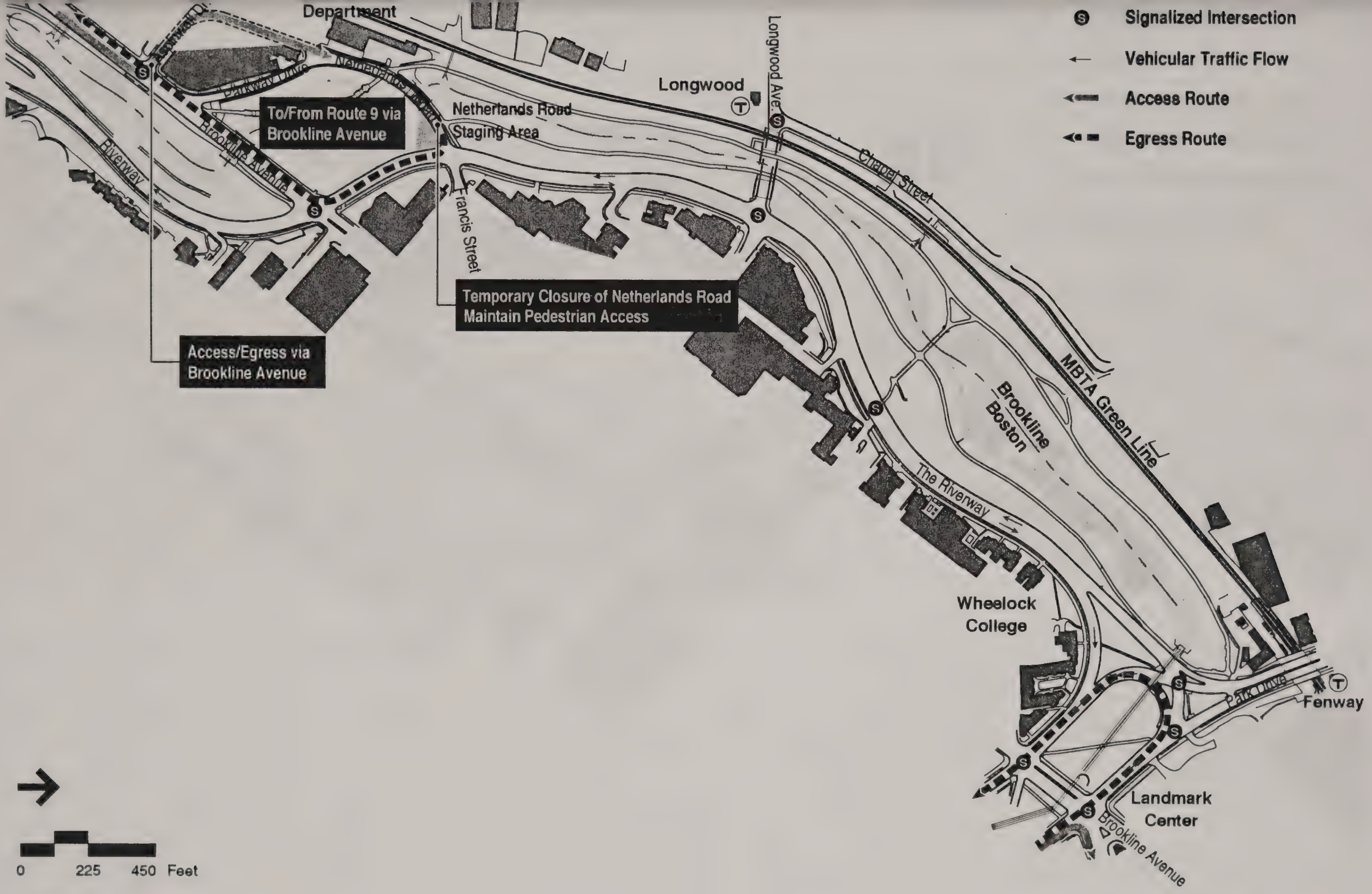

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Figure 5-19
Riverway Area Potential Staging Area
Access/Egress Plan for Construction Traffic
Source: VHB, Inc.

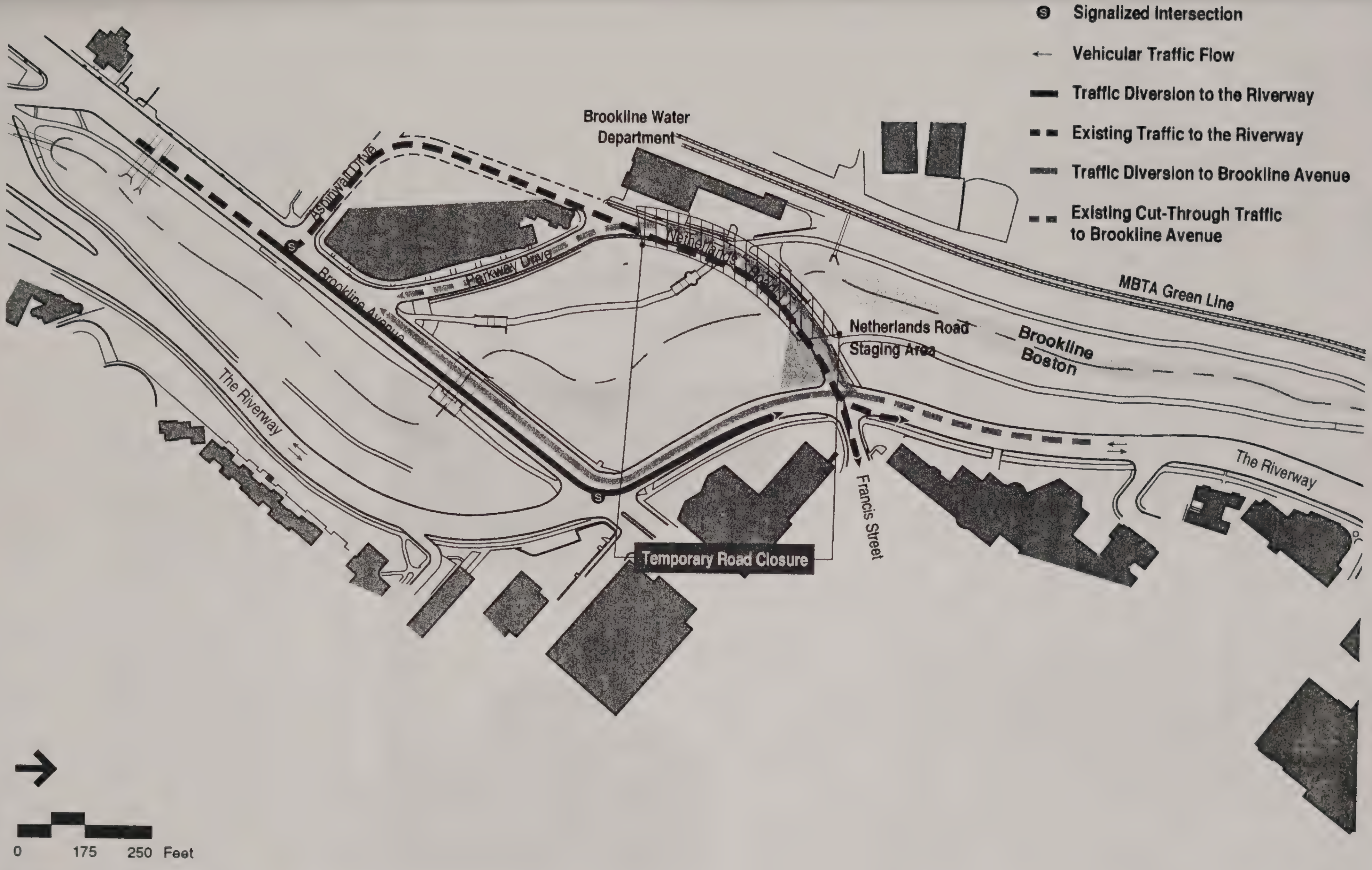
Signalized Intersection
Vehicular Traffic Flow
Traffic Diversion to the Riverway
Existing Traffic to the Riverway
Traffic Diversion to Brookline Avenue
Existing Cut-Through Traffic to Brookline Avenue
Brookline Water Department
Aspinwall Drive
Parkway Drive
Netherlands Road
Brookline Avenue
The Riverway
MBTA Green Line
Netherlands Road Staging Area
Brookline
Boston
Francis Street
Temporary Road Closure
S
S
0
175
250 Feet

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Figure 5-20
Riverway Area Netherlands Road
Traffic Diversions for General Traffic

Source: VHB, Inc.

Treatment in The Riverway will include the following activities:

After dredging is complete, the original shoreline and grading will be restored to the Primary Period of Significance. Stabilization of banks will include plant massing and the construction of "turf covered banks" to reflect the Primary Period of Significance. Planting will include wetland planting, bank planting and upland planting of both shrub and tree layers to improve wildlife habitat and to restore the historic designed landscape. Planting will include wetland plantings at the water's edge and planting of the banks and upland areas with plant material or turf as described above. This process will both rehabilitate the historic designed landscape and improve biodiverisity and wildlife habitat. The wetland plants selected will vary in height and at the turf bank will be high and dense enough to act as a deterrent to water fowl while still allowing for important views of the water. Primarily the Olmsted plant lists will be utilized for plant selection. See Figure 5- 21 and Preliminary Design Plans L-24 to L-36 in Appendix I.

Rehabilitation of the landscape, following removal of invasive materials such as *Phragmites* and Japanese Knotweed which exist on the banks and over water, will include both plant massing and the construction of "turf covered banks". Treatment plans will utilize conceptual plans, planting plans and planting lists prepared by the Olmsted firm during the Primary Period of Significance. The shoreline and grading of the land will also be restored to the Primary Period of Significance, using detailed grading plans prepared by the Olmsted firm at that time. Planting will include wetland planting at the water's edge and planting of the banks and upland areas with plant material as described above. This process will both rehabilitate the historic designed landscape and improve biodiversity and wildlife habitat. The wetland plants selected will vary in height and at turf banks will be high and dense enough to act as a deterrent to water fowl while still allowing important views of the water.

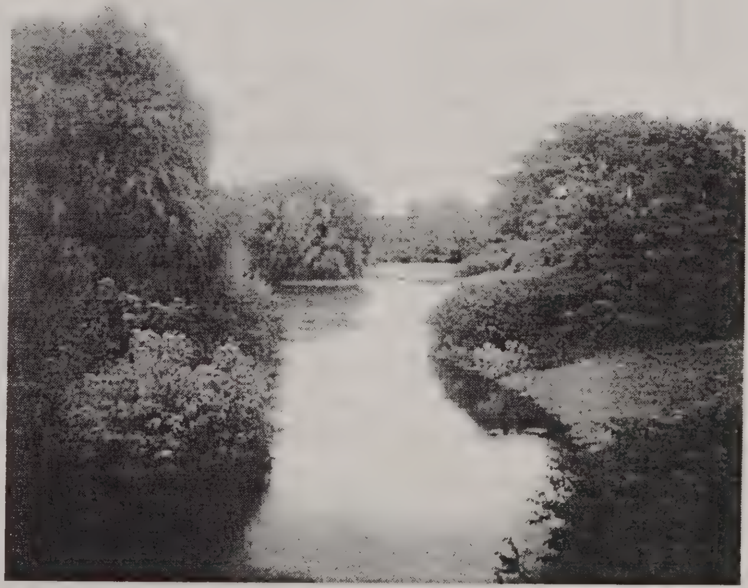


Figure 5-21
Looking Downstream from the St. Mary's Footbridge, 1907
Source: FLONHS

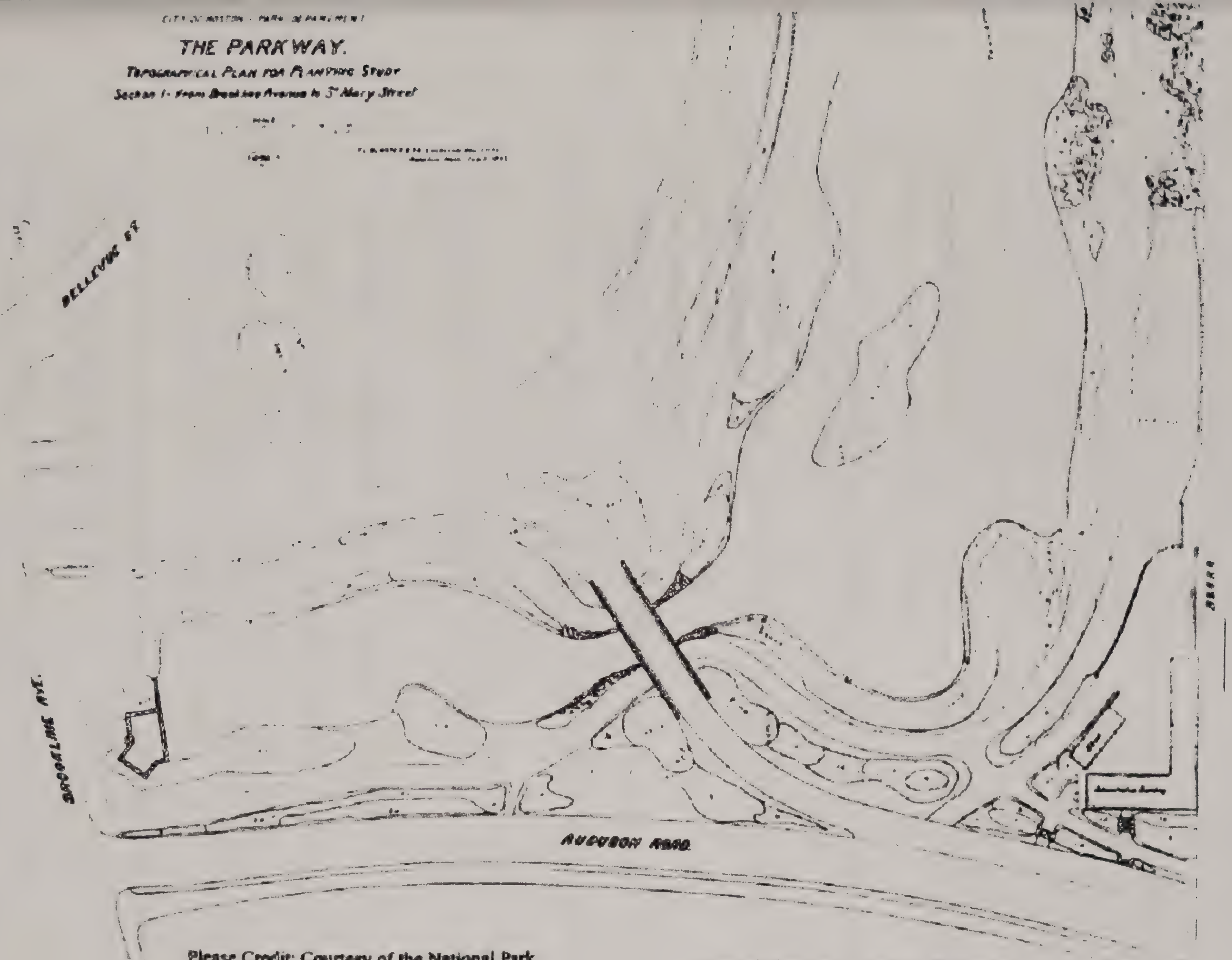
- The rehabilitation planting not only addresses the historic rehabilitation aspects of the project but also addresses Wetland Protection Act and habitat value. The proposed planting in Resource Areas under the Wetlands Protection Act will take into consideration species that will support the functioning of the resource areas, particularly BVW, Bank and Land Under Water. These plantings will be selected from the Olmsted plant list representing a diverse mix of species and selected for their habitat value. In this way rehabilitation is expected to meet historic, wetland and habitat considerations.

- In The Riverway there are two existing islands just north of the pedestrian and equestrian bridges near the Longwood MBTA Station. The goal will be to disturb these islands as little as possible, but when the *Phragmites* and other invasive species are removed, areas of disturbance on the islands will be replanted as described above. These islands are not accessible to the public now and will remain inaccessible thus continuing to provide safe wildlife habitat.

- Also in The Riverway, between Brookline Avenue and Netherlands Road, there is a large island with two bridges. This island always has been accessible to the public and will remain accessible. Invasive vegetation on banks and over water, such as *Phragmites* and Japanese Knotweed, will be removed and the river will be dredged to restore the original river configuration. Rehabilitation of the landscape will include both plant massing and the construction of turf covered banks to reflect the Primary Period of Significance. The original shoreline and grading will also be restored to the Primary Period of Significance. Planting will include wetland planting, bank planting and upland planting of both shrub and tree layers to improve wildlife habitat and to rehabilitate the landscape historically. Turf covered banks will include a wetland edge to improve wildlife habitat and lawn on banks and upland to restore the original historic viewsheds. The Olmsted plant lists will be utilized for plant selection. The mainland bank of the island (on the west) will not have a wetland shelf since the area is very narrow and the bank is steep. The island side can accommodate the wetland shelf. See Figure 5- 22.

- After completion of the dredging, the staging area at the Netherlands Road site will be rehabilitated. At Netherlands Road existing trees that will remain within or adjacent to the staging area will be protected and pruned. Existing paths and sidewalks will be rehabilitated, and existing lawn areas will be restored.

- In the staging areas to be rehabilitated and other portions of the park disturbed by contractor's operations, rehabilitation will include aeration and soil condition in accordance with standard horticultural practice. Any areas that have been compacted by the contractor's operations will receive the aeration and soil conditioning treatment. This practice also applies to other rehabilitation areas described in the following bullets.


City of Boston - Park Department
THE PARKWAY.
Topographical Plan for Planting Study
Section 1 - from Brookline Avenue to St Mary Street
BELLEVUE ST
BROOKLINE AVE.
AUDUBON ROAD

Please Credit: Courtesy of the National Park Service, Frederick Law Olmsted National Historic Site

Olmsted Plans and Drawings Collection
Plan # 930-60 Riverway Boston, MA
Topo Plan for Plating Study
1893

Figure 5-22
The Parkway Topographical Plan for Planning Study Section 1, from Brookline to St. Mary's Street, 1893
Source: FLONHS

- Existing desire line paths, which have resulted in erosion of lawn areas, will either be r regraded and constructed as new paths, or planting will be utilized to control and redirect movement in an effort to incorporate BMP's.

Replanting in staging areas and other disturbed areas will be dependent on the schedule of the work and optimum planting seasons. As dredging and bank stabilization work is completed, the contractor will be expected to provide temporary erosion control measures and then provide landscaping during the next planting season (generally spring or fall). The staging areas are expected to be the last areas vacated by the contractor, so they will be rehabilitated and replanted once the contractor removes equipment from the staging area at the completion of the work. Temporary erosion control measures will be used in the staging areas until the next planting season when vegetation is replanted.

In all replanted areas, the contractor will begin a two year guarantee and maintenance period once provisional acceptance is made of the planted material.

Refer to Preliminary Design Plans L-24 to L-36 included in Appendix I for proposed treatment in Riverway.

5.4 Leverett Pond

Construction activities that are proposed in the Leverett Pond area include:

- The formation of one staging area for sediment dewatering equipment and the subsequent loading of sediment into trucks;
- The improvement of the flood carrying capacity and historic bottom elevations via dredging and removal of approximately 23,900 cubic yards (CY) of accumulated sediment;
- Revegetation of the staging area upon completion of the work;
- Restoration of the Babbling Brook at the inlet to Leverett Pond from Willow Pond;
- The preservation of the historic park shoreline through the restoration of the natural bank and the enhancement of the view corridor associated with the re-orientation of the Daisy Field backstop/playing field;
- The preservation of the historic park features through the revegetation of the new bank, an island, and the establishment of wetlands areas and masses of upland vegetation plantings; and
- The repair or replacement of worn pathways and denuded ground.

Project objectives met by the above construction activities are summarized on Table 5-4. Six of the activities address three or more of the project objectives.

TABLE 5-4
PROJECT OBJECTIVES MET BY LEVERETT POND PROJECT ELEMENTS

	PROVIDE FLOOD CONTROL	*IMPROVE WATER QUALITY*	*ENHANCE AQUATIC & RIPARIAN HABITAT*	*REHABILITATE LANDSCAPE & HISTORIC RESOURCES*	*INSTITUTE BEST MANAGEMENT PRACTICES*
Dredge approximately 23,900 CY of sediment	Some improvement to Village Brook Drain	Removing sediments will improve water quality in pond	Removing sediments will improve bottom habitat and improve water quality	Restores historic capacity and shape of pond	None
Re-vegetate disturbed construction areas including staging areas	None	Reduces erosion from unvegetated areas	Results in more diverse aquatic and riparian habitat	Rehabilitates landscape treatment from Olmsted plant list	Reduces erosion from unvegetated areas
Re-vegetate disturbed bank areas and establish wetland areas	None	Reduces erosion from unvegetated areas	Results in more diverse aquatic and riparian habitat	Rehabilitates landscape treatment from Olmsted plant list	Reduces erosion from unvegetated areas
Restore view corridor by reorienting Daisy Field softball field	None	Reduces erosion from basebal field infield	None	Partially restores historic view feature of Olmsted Park	Reduces erosion from unvegetated ballfield areas
Rehabilitate historic island	None	Reduces erosion from unvegetated areas	Results in more diverse aquatic and riparian habitat	Rehabilitates historic feature of Olmsted Park	Reduces erosion from unvegetated areas
Re-vegetate Babbling Brook up to Willow Pond	None	None	Results in more diverse aquatic and riparian habitat	Rehabilitates historic feature of Olmsted Park	None
Repair / replace pathways and re-vegetate desire lines and unplanted areas	None	Reduces erosion from unvegetated areas	Results in more diverse aquatic and riparian habitat	Rehabilitates landscape treatment from Olmsted plant list	Reduces erosion from unvegetated areas

5.4.1 Dredging and Dredge Material Management

The pond cross section at Leverett Pond all has been reduced due to sediment deposition. While the reduction is not sufficient to be the cause of additional flooding, the historic capacity of the pond has been reduced. Restoration of the former cross sections returns these watercourses to their historic capacity and also increases the volume of the water bodies thereby increasing the amount of aquatic habitat available. Dredging also removes sediment that can be moved downstream, since the improved flood flows will create higher stream velocities.

Dredging and dredge material management discussed in the following sections will be accomplished similar to the dredge programs discussed in Section 5.1 and 5.2 using hydraulic dredging and dewatering methods.

Dredging in the Leverett Pond would be conducted using hydraulic dredging equipment and dewatering as discussed in Section 5.1. The Daisy Field staging area will be used for the dredging between Brookline Avenue near Netherlands Road and the upper end of Leverett Pond. Approximately 1.5 ft of sediment will be removed (about 23,900 cy) over most of the pond and more at the sand bar in front of the Village Brook Drain.

All sediments will be pumped to the staging area using flexible piping laid in the pond. It is anticipated that all material will be disposed of out-of-state. Approximately 7,200 cy of sediment from this location is sufficiently clean to meet in-state lined landfill chemical criteria, however the physical characteristics likely will prevent this.

5.4.2 Construction Staging

Through the Leverett Pond area, the proposed staging area location (Daisy Field) is at the Daisy Ballfield between Leverett Pond and the Jamaicaway. The staging area will encompass the northerly softball field. The southerly Little League field will be separated from the staging area by fencing and remain in use. Access to the staging area is via Willow Pond Road. The project will not require temporary roadway, lane, or sidewalk closures along the Jamaicaway or Willow Pond Road. All construction equipment will be staged off the existing travelway.

Staging at Leverett Pond as well as the other pond areas in Olmsted Park will not use staging areas other than Daisy Field and possibly the former Kelly Rink site. Staging for other downstream portions of the project are not expected to used Daily Field or the former Kelly Rink site. As a result, the work in the Olmsted Park area can proceed independently and not be tied to the schedule of downstream activities. This may allow Olmsted Park work to proceed earlier then some of the downstream work. The hydraulic improvements in the Olmsted Park area also should not measurably increase the impact immediately downstream if conducted before downstream improvements.

5.4.3 Traffic Management

Various alternative truck routes to/from the Daisy Field Staging Area were proposed and presented to the Citizens Advisory Committee and to representatives from the Boston Transportation Department, the MDC, and the Town of Brookline. For the Daisy Field Staging Area, Route 9 is the preferred regional route based on ease of access/egress. Using I-93 or I-90 to access this staging area would result in circuitous traffic patterns along roadways through neighborhoods that are not appropriate for truck traffic. From Route 9, the recommended access route follows Cypress Street to Pond Avenue to Willow Pond Road. The recommended egress route is the reverse of the access route (Pond Avenue to Cypress Street to Route 9). Figure 5- 23 presents the point of access/egress off Pond Avenue to Cypress Street. Figure 5-3 presents the project-wide truck routes.

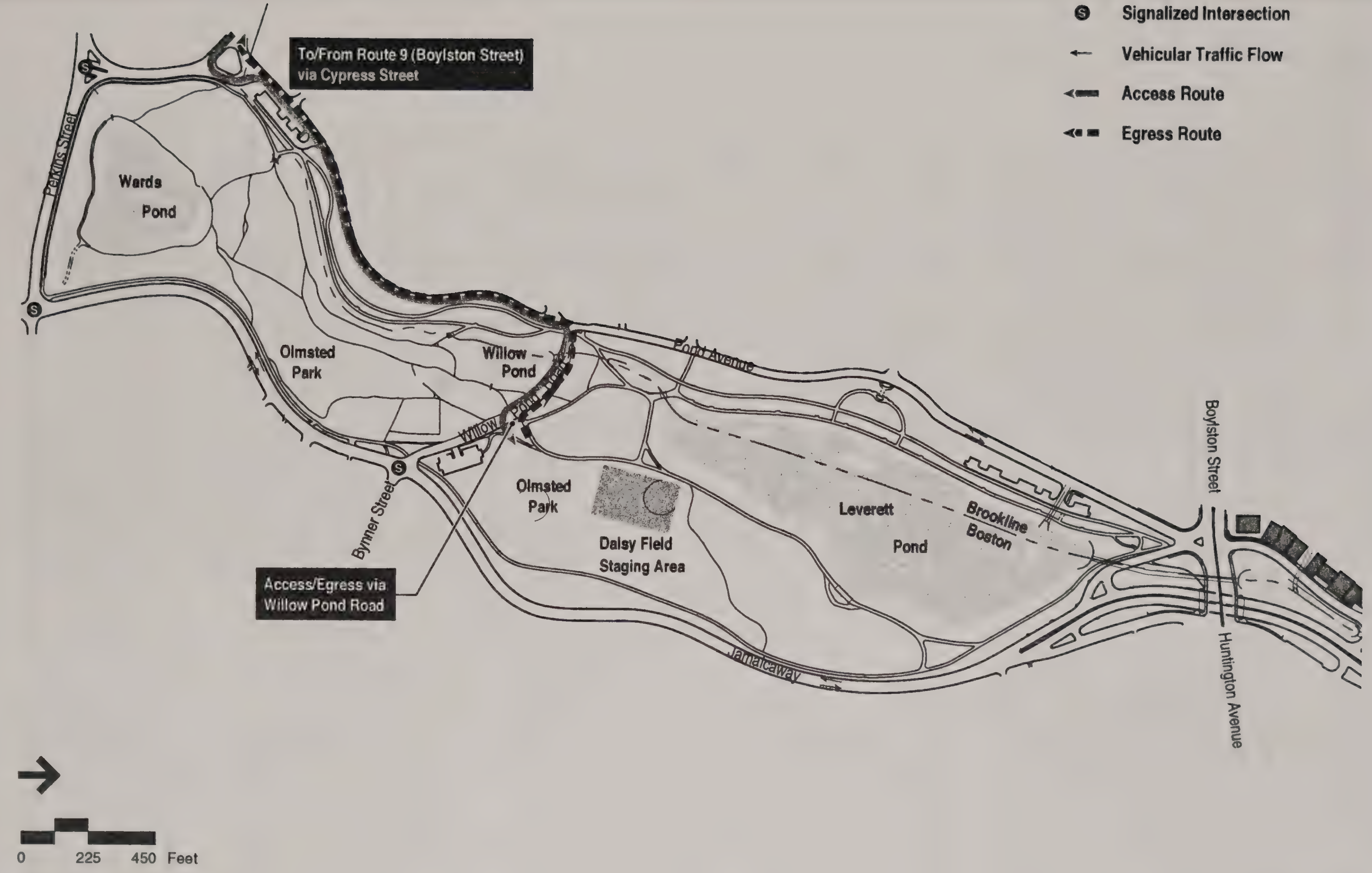
5.4.4 Landscape and Historic Resources

Treatment for landscape and historic resources affected by two types of project elements. This section discusses the proposed project elements that affect the treatment of the landscaping and associated historic resources. Dredging elements in The Riverway, Leverett Pond, Willow Pond, and Wards Pond affect historic resources because the justification for dredging in these areas is related more closely to returning the resource to its historic shape and form than strictly providing flood control or water quality. This is not to say that benefits to water quality and flood control do not accrue with the dredging, rather that they are not the principal reasons for dredging in these areas. The dredging elements are discussed in Section 5.4.1 although they have a significant historic element.

The existing site has extant historical resources with integrity from the Primary Period of Significance. Documentation of this area will provide the needed information to restore the shoreline after dredging and removal of invasive plant material from the banks and to identify and protect the extant features. Planting plans, grading plans, viewshed design and plant lists are complete for the Primary Period. These will provide the information needed to rehabilitate the areas disturbed during this segment of the project and to recover the landscape effect that Olmsted intended and that is documented in historic photographs. When plants are selected from the Olmsted lists factors such as height, color, texture, appropriateness for location, habitat value, maintainability and if they are now considered invasive will all be taken into consideration. See Preliminary Design Plans L-37 to L-43 in Appendix I for proposed treatment.

Treatment at Leverett Pond, as well as the restoration of the Babbling Brook from Willow Pond Road to Leverett Pond will include:

- After dredging is complete, any of the shoreline that is disturbed will be returned to the original shoreline and grading will be restored to the Primary Period of Significance. Stabilization of banks after dredging will include plant massing and



CDM Camp Dresser & McKee Inc.

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Figure 5-23
Leverett/Willow/Wards Pond Area
Potential Staging Area
Access/Egress Plan

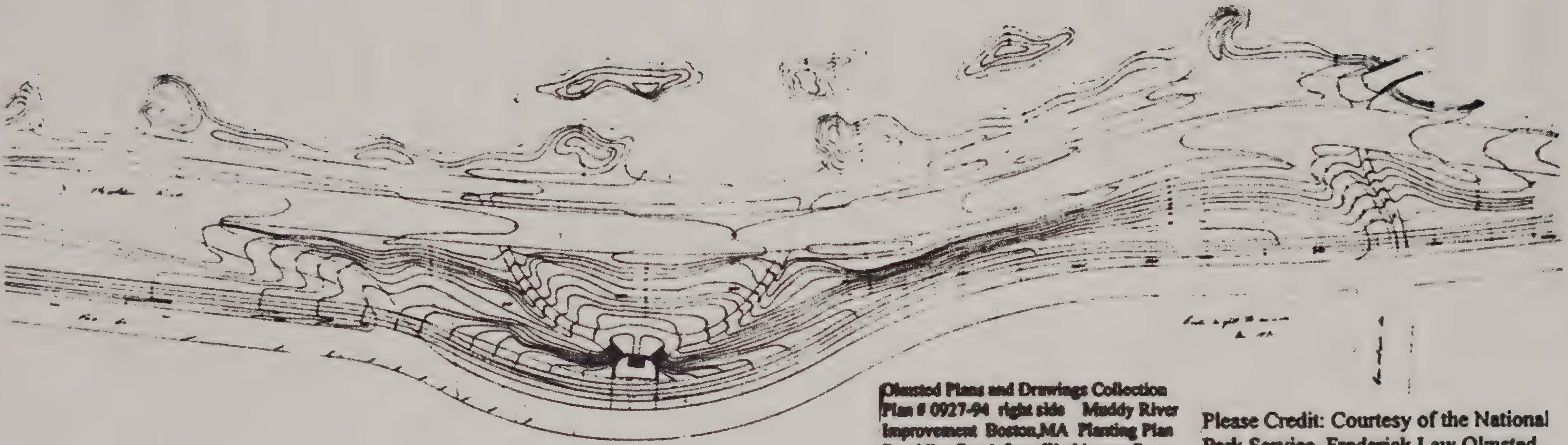
Source: VHB, Inc.

the construction of turf covered banks to reflect the Primary Period of Significance. Planting will include wetland planting, bank planting and upland planting of both shrub and tree layers to improve wildlife habitat and to historically restore the landscape. Turf covered banks will include a wetland edge to improve wildlife habitat and lawn on banks and upland to restore the original historic viewsheds. At Leverett Pond the restoration of the historic turf covered banks on the northeast side of the Pond will require restoration of an historic path to re-establish pedestrian access to the turf covered banks in keeping with the Primary Period. The Olmsted plant lists will be utilized for plant selection. The wetland plants selected will vary in height and at turf banks will be high and dense enough to act as deterrents to water fowl while still allowing important views of the water.

- Rehabilitation of the landscape and stabilized banks after removal and dredging of invasive materials such as Purple Loosestrife at the Pond and Japanese Knotweed at the Brook will include both plant massing and the construction of turf covered banks to reflect the Primary Period of Significance. The Brookline shoreline had gabions installed into the shoreline in the 1980's. Invasive plant material has taken hold in gabions as they have become silted. These invasive species will be removed, the gabions will be protected, and wetland plants will be planted into the gabions. Planting will include wetland planting, bank planting and upland planting of both shrub and tree layers to improve wildlife habitat and to historically restore the landscape. Turf covered banks at the pond will include a wetland edge to improve wildlife habitat and lawn on banks and upland to restore the original historic viewsheds. Planting at the Brook will include bank planting and upland planting of both shrub and tree layers to improve wildlife habitat and to historically restore the landscape. The Olmsted plant lists will be utilized for plant selection. The wetland plants selected will vary in height and at turf banks will be high and dense enough to act as deterrents to water fowl while still allowing important views of the water. See Figure 5- 24.

- Rehabilitation of the landscape and stabilization of banks, after dredging, will involve planting of trees, shrubs, ground cover, and turf. Treatment plans will utilize conceptual plans, planting plans and planting lists prepared by the Olmsted firm during the Primary Period of Significance. The shoreline and grading of the land will be restored to the Primary Period of Significance, using detailed grading plans prepared by the Olmsted firm. Planting will include wetland plantings at the water’s edge and planting of the banks and upland areas with plant material as described above. This process will both restore the historic designed landscape and improve biodiversity and wildlife habitat.

- The rehabilitation planting not only addresses the historic rehabilitation aspects of the project but also addresses Wetland Protection Act and habitat value. The proposed planting in Resource Areas under the Wetlands Protection Act will take into consideration species that will support the functioning of the resource areas, particularly BVW, Bank and Land Under Water. These plantings will be selected from the Olmsted plant list representing a diverse mix of species and selected for



Olmsted Plans and Drawings Collection
Plan # 0927-94 right side Muddy River
Improvement Boston,MA Planting Plan
Brookline Road from Washington St. to
Cumberland Av. Dec. 1891

Please Credit: Courtesy of the National
Park Service, Frederick Law Olmsted
National Historic Site.

Figure 5-24
Grading Plan Brookline Road from Washington St. to Cumberland Ave., December 1891
Source: FLONHS

their habitat value. In this way rehabilitation is expected to meet historic, wetland and habitat considerations.

- The Olmsted grading plans and photographs also show the "Olmsted beaches", which were widenings of the paths that allowed access to the water edge and were made of the same material as the path. In Olmsted's period these were gravel paths. The elevation of the water in Leverett Pond is about three feet lower than the elevation shown on the Olmsted grading plans. This has resulted over time in the change of the banks from the original Olmsted designed gradual sloping beaches to steep turf-covered banks that extend to the water edge. The restoration of the beaches will be difficult to impossible on the Brookline side, unless the water level is raised and regrading is possible between the current shoreline and the adjacent extant footpaths.

- The "beach" on the Boston side may be the only one that can be regarded to work but it will also require restoration of a historic path to re-establish pedestrian access to the beach in keeping with the Primary Period. Another equally serious issue is that the beaches must be constructed with a wetland shelf for planting to act as a deterrent to waterfowl.

- In Olmsted Park there are three islands. The two larger islands are the original historic islands. They currently provide safe wildlife habitat. They are not accessible to the public and will remain inaccessible. The third or center island was reconstructed in the 1980's. The island was not shaped correctly, the plantings were not successful and the island has minimal vegetative cover today. The goal will be to disturb the two larger islands as little as possible to remove invasive species. When invasive species are removed, the disturbed areas on the islands will be replanted as described above. The third island will be reshaped and planted to reflect the Primary Period of Significance. Planting will include wetland planting, bank planting and upland planting of both shrub and tree layers to create wildlife habitat and to restore the landscape historically. The goal for this third island will be to replicate the other two islands including their inaccessibility to the public thus providing safe wildlife habitat. The Olmsted plant lists will be utilized for plant selection. When plants are selected from the Olmsted lists, factors such as height, color, texture, appearance for location, habitat value, maintainability and if they are now considered invasive will all be taken into consideration.

- After completion of the dredging, the staging area at the Daisy Field area will be rehabilitated. At Daisy Field existing trees to remain adjacent or within the staging area will be protected and pruned, existing paths will be rehabilitated, existing lawn areas will be restored and the existing ball field complete with lighting, backstop, seating and fencing will be re-oriented in conformance with the 1990 Emerald Necklace Masterplan. The intent of the re-orientation is to respect the continuum by retaining the current active use of this area, but to move the ballfield equipment out of the view, to have lights shielded to illuminate only the ballfields, and to install timers so the lights are turned off after 10:00 p.m. The area will not be restored to the Primary Period when it was an open meadow, for it will still be a mown playing field with a combination of grass and infield mix. The re-oreintation will again open up the historic long viewshed re-establishing the original tranquil, restful and soothing effect of the view and its special quality, at least when no ball games are in progress.

- In the staging areas to be rehabilitated and other portions of the park disturbed by contractor's operations, rehabilitation will include aeration and soil condition in accordance with standard horticultural practice. Any areas that have been compacted by the contractor's operations will receive the aeration and soil conditioning treatment. The practice also appears to other rehabilitation areas described in the preceding bullets.

Replanting in staging areas and other disturbed areas will be dependent on the schedule of the work and optimum planting seasons. As dredging and bank stabilization work is completed, the contractor will be expected to provide temporary erosion control measures and then provide landscaping during the next planting season (generally spring or fall). The staging areas are expected to be the last areas vacated by the contractor, so they will be rehabilitated and replanted once the contractor removes equipment from the staging area at the completion of the work. Temporary erosion control measures will be used in the staging areas until the next planting season when vegetation is replanted.

In all replanted areas, the contractor will begin a two year guarantee and maintenance period once provisional acceptance is made of the planted material.

Refer to Preliminary Design Plans L-37 to L-43 in Appendix I for proposed treatment in the Leverett Pond area.

5.5 Willow Pond

Construction activities that are proposed in the Willow Pond area include:

- The restoration of the historic pond capacity by the dredging and removal of approximately 5,900 cubic yards (cy) of accumulated sediment;
- The rehabilitation of the terrestrial habitat with indigenous plantings;
- Enhancement of the habitat of the three-spine stickleback;
- The preservation of the historic park shoreline through the restoration of the natural bank;
- The preservation of the historic park features via the revegetation of the new bank, the re-introduction of an island, and the establishment of wetland areas and the restoration of terrestrial habitat with indigenous plantings;
- The repair of the rock dam between Spring Pond and Willow Pond; and

- The repair or replacement of worn pathways and denuded ground.

Project objectives met by the above construction activities are summarized on Table 5-5. Four of the activities address three or more of the project objectives.

5.5.1 Dredging and Dredge Material Management

The pond cross section at Willow Pond has been reduced due to sediment deposition. While the reduction is not sufficient to be the cause of additional flooding, the historic capacity of the pond has been reduced. Restoration of the former cross section returns this watercourse to its historic capacity and also increases the volume of the water bodies thereby increasing the amount of aquatic habitat available. Dredging also removes sediment that can be moved downstream, since the improved flood flows will create higher stream velocities.

Dredging and dredge material management discussed in the following sections will be accomplished similar to the dredge programs discussed in Section 5.1 and 5.2 using hydraulic dredging and dewatering methods.

Approximately 5,900 cy of sediment (about 6 feet of depth) will be removed from Willow Pond. All sediments will be removed by hydraulic dredging as discussed in Section 5.1.2. Willow Pond sediments are contaminated with PAHs and petroleum, mandating disposal in an out-of-state landfill.

The proposed staging area location for Willow Pond dredging is at the Daisy Field between Leverett Pond and the Jamaicaway. Access to the staging area is via Willow Pond Road.

The project will not require temporary roadway, lane, or sidewalk closures along the Jamaicaway or Willow Pond Road. All construction equipment will be staged off the existing travelway.

Staging and traffic management issues are the same as discussed in Section 5.4 under Leverett Pond.

5.5.2 Landscape and Historic Resources

Under Section 5.4.2, it was noted that the purpose of most of the dredging in the Olmsted Park area is to restore the ponds and waterways to their historic configuration. In Willow Pond, the historic element is only part of the reason for dredging, as contaminated sediments have degraded the environment of the pond and dredging helps to meet the water quality improvement objectives.

The existing site has extant historical resources with integrity from the Primary Period of Significance. Documentation of this area will provide the needed information to restore the shoreline after dredging and removal of invasive plant material from the banks and to identify and to protect the extant features. Planting plans, grading plans, viewshed design and plant lists are complete for the Primary Period and will

TABLE 5-5
PROJECT OBJECTIVES MET BY WILLOW POND PROJECT ELEMENTS

	PROVIDE FLOOD CONTROL	***IMPROVE WATER QUALITY***	***ENHANCE AQUATIC & RIPARIAN HABITAT***	***REHABILITATE LANDSCAPE & HISTORIC RESOURCES***	***INSTITUTE BEST MANAGEMENT PRACTICES***
Dredge approximately 5,900 CY of sediment	None	Removing sediments will improve water quality in pond	Removing sediments will improve bottom habitat and improve water quality	Restores historic capacity and shape of pond	None
Re-vegetate disturbed bank areas and establish wetland areas	None	Reduces erosion from unvegetated areas	Results in more diverse aquatic and riparian habitat	Rehabilitates landscape treatment from Olmsted plant list	Reduces erosion from unvegetated areas
Rehabilitate historic island	None	None	Results in more diverse aquatic and riparian habitat	Rehabilitates historic feature of Olmsted Park	None
Enhancement of three spine stickleback habitat and rock dam outlet of Spring Pond		Slightly improves water quality in Babbling Brook tributary	Results in improved aquatic habitat for three spine stickleback	Restores one of the history pool areas in Olmsted Park	None
Repair / replace pathways and re-vegetate desire lines and unplanted areas	None	Reduces erosion from unvegetated areas	Results in more diverse aquatic and riparian habitat	Rehabilitates landscape treatment from Olmsted plant list	Reduces erosion from unvegetated areas

provide the information needed to rehabilitate the areas disturbed during this project and to recover the landscape effect that Olmsted intended and that is documented in the historic photographs. See Preliminary Design Plans L-44 to L-47 in Appendix I for proposed treatment.

Treatment for Willow Pond, as well as, the restoration of the Babbling Brook from Wards Pond to Willow Pond will include:

- After dredging is complete, the original shoreline and grading will be restored to the Primary Period of Significance. Stabilization of banks after dredging will include plant massing and the construction of turf covered banks to reflect the Primary Period of Significance. Planting will include wetland planting, bank planting and upland planting of both shrub and tree layers to improve wildlife habitat and to historically restore the landscape. Turf covered banks will include a wetland edge to improve wildlife habitat and lawn on banks and upland to restore the original historic viewsheds. At Willow Pond the rehabilitation of the historic turf covered banks on the northeast side of the Pond will require rehabilitation of an historic path connecting Willow Pond to Willow Pond Road. The Olmsted plant lists will be utilized for plant selection. When plants are selected from the Olmsted lists, factors such as height, color, texture, appropriateness for location, habitat value, maintainability and if they are now considered invasives will all be taken into consideration. The wetland plants selected will vary in height and at turf banks will be high and dense enough to act as a deterrent to waterfowl while still allowing important views of the water.

- Rehabilitation of the landscape after removal and dredging of invasive materials such as Japanese Knotweed will occur at both the pond banks and on the banks of the Babbling Brook. Restoration will include both plant massing at the Pond and Brook and the construction of turf covered banks at the pond in order to reflect the Primary Period of Significance. Planting at the pond will include wetland planting, bank planting, and upland planting of both shrub and tree layers to improve wildlife habitat and to restore the landscape historically. Planting at the Brook will include bank planting and upland planting of both shrub and tree layers to improve wildlife habitat and to historically restore the landscape to the Primary Period of Significance. The Olmsted plant lists will be utilized for plant selection for both the Pond and Brook. When plants are selected from the Olmsted lists, factors such as height, color, texture, appropriateness for location, habitat value, maintainability and if they are now considered invasives will all be taken into consideration. The wetland plants selected will vary in height and at turf banks will be high and dense enough to act as a deterrent to waterfowl while still allowing important views of the water.

- The rehabilitation planting not only addresses the historic rehabilitation aspects of the project but also addresses Wetland Protection Act and habitat value. The proposed planting in Resource Areas under the Wetlands Protection Act will take into consideration species that will support the functioning of the resource areas, particularly BVW, Bank and Land Under Water. These plantings will be selected from the Olmsted plant list representing a diverse mix of species and selected for their habitat value. In this way rehabilitation is expected to meet historic, wetland and habitat considerations.

- Rehabilitation of the shoreline will include restoration of the culvert bridge with pudding stone "teeth" and rock bank (waterfall) from Spring Pond into Willow Pond. It also will include the resetting of stones in the Babbling Brook from Wards Pond to Willow Pond and the small waterfall under the pedestrian bridge on the upstream side of the Pond. Restoration of these features will reflect the Primary Period of Significance. See Figure 5- 25.

- Dredging of Wards Pond will require piping to be laid on the path above the Brook between Wards and Willow. Any disturbance of paths or landscape in this area will be replaced in kind. The path currently is a stone dust path and vegetation is an herbaceous and shrub layer under woodland trees. The dredging of Willow Pond will require piping across Willow Pond Road to the Daisy Field area. Paths, lawns, and planting will be replaced in kind.

- In portions of the park disturbed by contractor's operations, rehabilitation will include aeration and soil condition in accordance with standard horticultural practice. Any areas that have been compacted by the contractor's operations will receive the aeration and soil conditioning treatment. This practice also applies to other rehabilitation areas described in the preceding bullets.

Replanting in staging areas and other disturbed areas will be dependent on the schedule of the work and optimum planting seasons. As dredging and bank stabilization work is completed, the contractor will be expected to provide temporary erosion control measures and then provide landscaping during the next planting season (generally spring or fall). The staging areas are expected to be the last areas vacated by the contractor, so they will be rehabilitated and replanted once the contractor removes equipment from the staging area at the completion of the work. Temporary erosion control measures will be used in the staging areas until the next planting season when vegetation in replanted. In all replanted areas, the contractor will begin a two year guarantee and maintenance period once provisional acceptance is made of the planted material.

Refer to Preliminary Design Plans L-44 to L-47 in Appendix I for proposed treatment in the Willow Pond area.

Figure
Willow Pond Waterfall from History Pool 1
Source: B

5.6 Wards Pond

Construction activities that are proposed at Wards Pond include:

- The restoration of historic pond capacity by the dredging and removal of approximately 15,600 cubic yards (cy) of accumulated sediment;
- The rehabilitation of the terrestrial habitat with indigenous plantings;
- The preservation of historic park features via the establishment of wetland species in the outlet brook from the Pond;
- The preservation of the historic park shoreline through the rehabilitation of the historic turf-covered bank shoreline and outlet bridge; and
- The repair or replacement of the worn pathways and denuded ground.

Project objectives met by the above construction activities are summarized on Table 5-6. Three of the activities address three or more of the project objectives.

5.6.1 Dredging and Dredge Material Management

The pond cross section at Wards Ponds has been reduced due to sediment deposition. While the reduction is not sufficient to be the cause of additional flooding, the historic capacity of the pond has been reduced. Restoration of the former cross section returns this watercourse to its historic capacity and also increases the volume of the water bodies thereby increasing the amount of aquatic habitat available. Dredging also removes sediment that can be moved downstream, since the improved flood flows will create higher stream velocities.

Dredging and dredge material management discussed in the following sections will be accomplished similar to the dredge programs discussed in Section 5.1 and 5.2 using hydraulic dredging and dewatering methods.

Approximately 4 feet of sediment will be removed from Wards Pond (about 15,600 cy). Sediments will be removed by hydraulic dredging. The pond will be restored to its historic depth to prevent the wetland plant species, which currently inhabit the shoreline, from encroaching into the entire pond.

About 10 percent or 1,500 cy of the Wards Pond sediment will be disposed of as hazardous waste as indicated in Appendix F. The remainder will be disposed of in an out-of-state landfill. Nearly 9,300 cy of the material is clean enough for disposal in an unlined in-state landfill but the physical characteristics may preclude this.

The proposed staging area location for Wards Pond dredging is at the Daisy Field between Leverett Pond and the Jamaicaway. Access to the staging area is via Willow Pond Road. The project will not require temporary roadway, lane, or sidewalk

TABLE 5-6
PROJECT OBJECTIVES MET BY WARDS POND PROJECT ELEMENTS

	PROVIDE FLOOD CONTROL	*IMPROVE WATER QUALITY*	*ENHANCE AQUATIC & RIPARIAN HABITAT*	*REHABILITATE LANDSCAPE & HISTORIC RESOURCES*	*INSTITUTE BEST MANAGEMENT PRACTICES*
Dredge approximately 15,600 CY of sediment	None	Removing sediments will improve water quality in pond	Removing sediments will improve bottom habitat and improve water quality	Restores historic capacity and shape of pond	None
Re-vegetate disturbed areas	None	Reduces erosion from unvegetated areas	Results in more diverse aquatic and riparian habitat	Rehabilitates landscape treatment from Olmsted plant list	Reduces erosion from unvegetated areas
Preservation of historic shoreline by restoring historic turf covered bank areas	None	None	Preserves healthy diverse habitat at shoreline	Preserves historic shoreline of pond	None
Repair / replace pathways and re-vegetate desire lines and unplanted areas	None	Reduces erosion from unvegetated areas	Results in more diverse aquatic and riparian habitat	Rehabilitates landscape treatment from Olmsted plant list	Reduces erosion from unvegetated areas

closures along the Jamaicaway or Willow Pond Road. All construction equipment will be staged off the existing travelway.

Staging and traffic management issues are the same as discussed in Section 5.4 under Leverett Pond with the exception of parking. A small parking area off the Chestnut Street side of Wards Pond will be needed during mobilization and demobilization. The Town of Brookline indicated this temporary loss could be accommodated.

5.6.2 Landscape and Historic Resources

The existing site has extant historical resources with integrity from the Primary Period of Significance. Documentation of this area will provide the needed information to restore the shoreline after dredging and removal of invasive plant material from the banks and to identify and protect the extant features. Planting plans, grading plans, viewshed design and plant lists are complete for the Primary Period. These will provide the information needed to rehabilitate the areas disturbed during this project and to recover the landscape effect that Olmsted intended and that is documented in the historic photographs. See Preliminary Design Plans L-48 to L-49 in Appendix I for treatment.

Treatment at Ward's Pond will include:

- After dredging is complete, the original shoreline and grading will be restored to the Primary Period of Significance in areas disturbed during construction. This disturbed area is expected to be minimal in extent. Most of the shoreline will not be disturbed. Stabilization of banks after dredging disturbance will include plant massing and the construction of turf covered banks to reflect the Primary Period of Significance. Planting in disturbed areas will include wetland planting, bank planting and upland planting of both shrub and tree layers to improve wildlife habitat and to restore the landscape historically. Turf covered banks will include a wetland edge to improve wildlife habitat and lawn on banks and upland to restore the original historic viewsheds. The Olmsted plant lists will be utilized for plant selection. When plants are selected from the Olmsted lists, factors such as height, color, texture, appropriateness for location, habitat value, maintainability and if they are now considered invasives will all be taken into consideration. The wetland plants selected will vary in height and at turf banks will be high and dense enough to act as a deterrent to waterfowl while still allowing important views of the water.

- The Olmsted grading plans and photographs also show three "Olmsted beaches", which were widenings of the paths that allowed access to the water edge and were made of the same material as the path. By 1903 photographic documentation shows these beaches as turf-covered banks with a wetland edge at the shoreline (see Figure 5-26). All three areas are totally overgrown with invasive species. The process will be to restore the turf-covered banks and improve biodiversity and wildlife habitat.

- Rehabilitation of the landscape after removal and dredging of invasive materials such as Japanese Knotweed and Water Willow from banks and over water will include both plant massing and the construction of turf covered banks to reflect the Primary Period of Significance. Three turf-covered banks were designed by Olmsted to provide important viewsheds of and within the Pond. Planting of these turf-covered banks will include a wetland edge to improve wildlife habitat and lawn on banks and upland to rehabilitate the original historic viewsheds. The Olmsted plant lists will be utilized for plant selection. When plants are selected from the Olmsted lists, factors such as height, color, texture, appropriateness for location, habitat value, maintainability and if they are now considered invasives will all be taken into consideration. The wetland plants selected will vary in height and at turf banks will be high and dense enough to act as a deterrent to waterfowl while still allowing important views of the water. See Figure 5- 26.

- The rehabilitation planting not only addresses the historic rehabilitation aspects of the project but also addresses Wetland Protection Act and habitat value. The proposed planting in Resource Areas under the Wetlands Protection Act will take into consideration species that will support the functioning of the resource areas, particularly BVW, Bank and Land Under Water. These plantings will be selected from the Olmsted plant list representing a diverse mix of species and selected for their habitat value. In this way rehabilitation is expected to meet historic, wetland and habitat considerations.

- Rehabilitation of the shoreline will also include restoration of the culvert bridge with pudding stone "teeth" at the outlet at Babbling Brook in accordance with the Olmsted Primary Period of Significance. This culvert bridge collapsed and currently stepping stones in the water provide the means for crossing. An existing culvert bridge at the southwest corner of the boardwalk is still functioning and is a duplicate of the missing crossing. The banks and paths on either side of the collapsed culvert crossing are silting into the water so reconstruction will serve as a BMP mitigation.

- Access into Wards Pond will impact an existing historic bridge and the path and banks of the Pond. The bridge will be protected as will existing heritage trees and woodland plantings. Access to the site will utilize the entry drive into an existing parking lot off Pond Avenue. Any damage to existing features will be replaced in kind. The path is currently a stone dust path and vegetation is an herbaceous and shrub layer under woodland trees.

In portions of the park disturbed by contractor's operations, rehabilitation will include aeration and soil condition in accordance with standard horticultural practice. Any areas that have been compacted by the contractor's operations will receive the aeration and soil conditioning treatment. This practice also applies to other rehabilitation areas described in the preceding bullets.

Replanting in staging areas and other disturbed areas will be dependent on the schedule of the work and optimum planting seasons. As dredging and bank stabilization work is completed, the contractor will be expected to provide temporary erosion control measures and then provide landscaping during the next planting season (generally spring or fall). The staging areas are expected to be the last areas vacated by the contractor, so they will be rehabilitated and replanted once the contractor removes equipment from the staging area at the completion of the work. Temporary erosion control measures will be used in the staging areas until the next planting season when vegetation is replanted.

In all replanted areas, the contractor will begin a two year guarantee and maintenance period once provisional acceptance is mad of the planted material.

Refer to Preliminary Design Plans L-48 to L-49 In Appendix I for proposed treatment in the Willow Pond area.

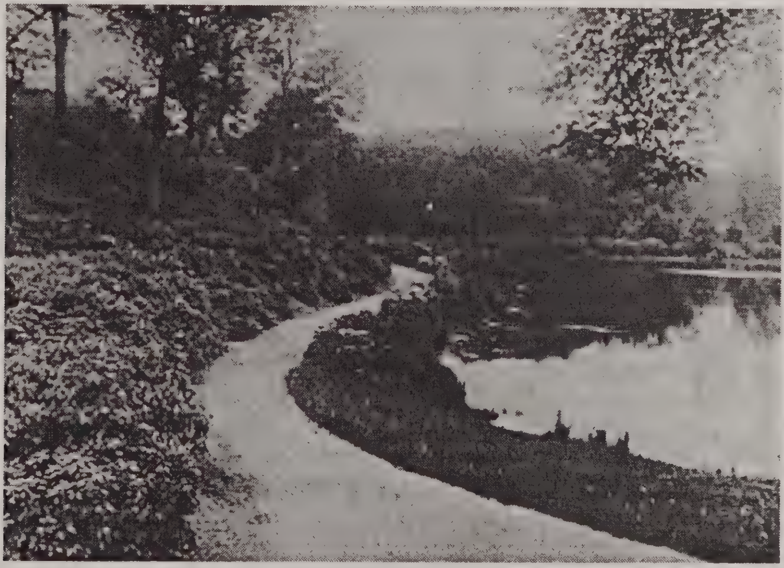


Figure 5-26
East Side of Ward's Pond Looking South, 1900

5.7 Best Management Practices for Stormwater Runoff

As discussed in Section 2.5, a variety of source and treatment control BMPs were considered for inclusion in the BMP plan for the Muddy River watershed. Section 2.5.4.1 and 2.5.4.2 list the selected alternatives for the plan. These alternatives are discussed in further detail in the following sections. BMPs address two project objectives: they improve water quality and implement BMPs.

The BMPs to be implemented are summarized on Table 5-7 with anticipated funding sources and responsibility. In Table 5-7 the designation of capital program means the BMP is part of the Muddy River Restoration Project capital costs. The annual capital budget refers to an annual capital appropriation by the responsible agency. A proposed timeline for implementing BMPs discussed in the section are included in Figure 5-27.

Best Management Practice (BMP)	Responsibility	Type of BMP	Anticipated Source of Funds	Water Quality Problem Addressed
Basin-Wide Source Control BMPs				
Annual water quality sampling program	Administered centrally with shared cost	Non-structural	Annual capital budget	Monitors overall water quality improvement
Improved street sweeping program	Boston PWD	Non-structural	Annual operating budget	Reduces discharge of solids to river system
	Brookline DPW	Non-structural	Annual operating budget	Reduces discharge of solids to river system
	MDC	Non-structural	Annual operating budget	Reduces discharge of solids to river system
Institute catch basin cleaning / tracking program	BWSC	Non-structural	Annual operating budget	Reduces discharge of solids to river system
	Brookline DPW	Non-structural	Annual operating budget	Reduces discharge of solids to river system
	MDC	Non-structural	Annual operating budget	Reduces discharge of solids to river system
Trail maintenance	BPRD	Non-structural	Annual capital budget	Reduces discharge of solids to river system
	Brookline POS	Non-structural	Annual capital budget	Reduces discharge of solids to river system
	MDC	Non-structural	Annual capital budget	
Public education program	Administered centrally, cost shared Boston, Brookline	Non-structural	Annual capital budget	Improves public participation in controlling litter, pet feces and lawn chemicals from entering river
Waterfowl control program	BPRD	Non-structural	Annual operating budget	Reduces incidences of waterfowl pollution of river
	Brookline POS	Non-structural	Annual operating budget	Reduces incidences of waterfowl pollution of river
Catch basin labeling program	MDC	Non-structural	Annual capital budget	Reduces incidences of pollution due to dumping in catch basins
Improve enforcement of pooper scooper laws	BPRD	Non-structural	Annual operating budget	Improves ability of governing entities to enforce bylaws controlling pollution
	Brookline POS	Non-structural	Annual operating budget	Improves ability of governing entities to enforce bylaws controlling pollution
Review and strengthen stormwater regulations	Brookline DPW	Non-structural	Annual operating budget	Improves ability of governing entities to enforce bylaws controlling pollution

Table 5-7
Summary of Watershed BMPs

Best Management Practice (BMP)	Responsibility	Type of BMP	Anticipated Source of Funds	Water Quality Problem Addressed
Basin-Wide Treatment Control BMPs				
Pilot particle separator program and basin BMP evaluation	Administered centrally with shared cost	Non-structural	Annual capital budget	Reduces discharge of solids to river system
Back Bay Fens - Source Control BMPs				
Public education program for pesticide / herbicide /fertilizer use	BPRD	Non-structural	Annual capital budget	
Correction of desire lines with revegetation	BPRD	Non-structural	Annual capital budget	Reduces discharge of solids to river system
Repair drainage system and curbs along roadways	MDC	Structural	Annual capital budget	Reduces discharge of solids to river system
Back Bay Fens - Treatment Control BMPs				
Vegetated swale in Victory Garden	Part of capital program	Structural	Projects capital program	Reduces discharge of solids to river system
Design and construct particle separator at Emmanuel College Drain	BWSC	Structural	Projects capital program	Reduces discharge of solids to river system
Design and construct sedimentation basins in river	Part of capital program	Structural	Projects capital program	Captures particles reaching river for centralized removal
Design and construct particle separator for MDC storm drains	MDC	Structural	Projects capital program	Reduces discharge of solids to river system
Riverway - Source Control BMPs				
Correction of desire lines with revegetation	BPRD	Non-structural	Annual capital budget	Reduces discharge of solids to river system
Repair drainage system and curbs along roadways	MDC	Structural	Annual capital budget	Reduces discharge of solids to river system
Riverway - Treatment Control BMPs				

Table 5-7
Summary of Watershed BMPs

Best Management Practice (BMP)	Responsibility	Type of BMP	Anticipated Source of Funds	Water Quality Problem Addressed
Design and construct sedimentation basins in river	Part of capital program	Structural	Projects capital program	Captures particles reaching river for centralized removal
Leverett Pond - Treatment Control BMPs				
Potential particle separators or other treatment controls	Part of capital program	Structural	Projects capital program	Reduces discharge of solids to river system
Design and construct particle separator at Daisy Field Drain	Part of capital program	Structural	Projects capital program	Reduces discharge of solids to river system
Design and construct sedimentation basins in river	Part of capital program	Structural	Projects capital program	Captures particles reaching river for centralized removal
Willow Pond - Source Control BMPs				
Correction of desire lines with revegetation	BPRD	Non-structural	Annual capital budget	Reduces discharge of solids to river system
	BPOS	Non-structural	Annual capital budget	Reduces discharge of solids to river system
Willow Pond - Treatment Control BMPs				
Design and construct particle separator at Chestnut Street Drain	Brookline DPW	Structural	Projects capital program	Reduces discharge of solids to river system
Design and construct sedimentation basins in river	Part of capital program	Structural	Projects capital program	Captures particles reaching river for centralized removal

Note: MDC BMPs are proponents recommended items for MDC participation in order to achieve consistent BMPs.

Table 5-7
Summary of Watershed BMPs

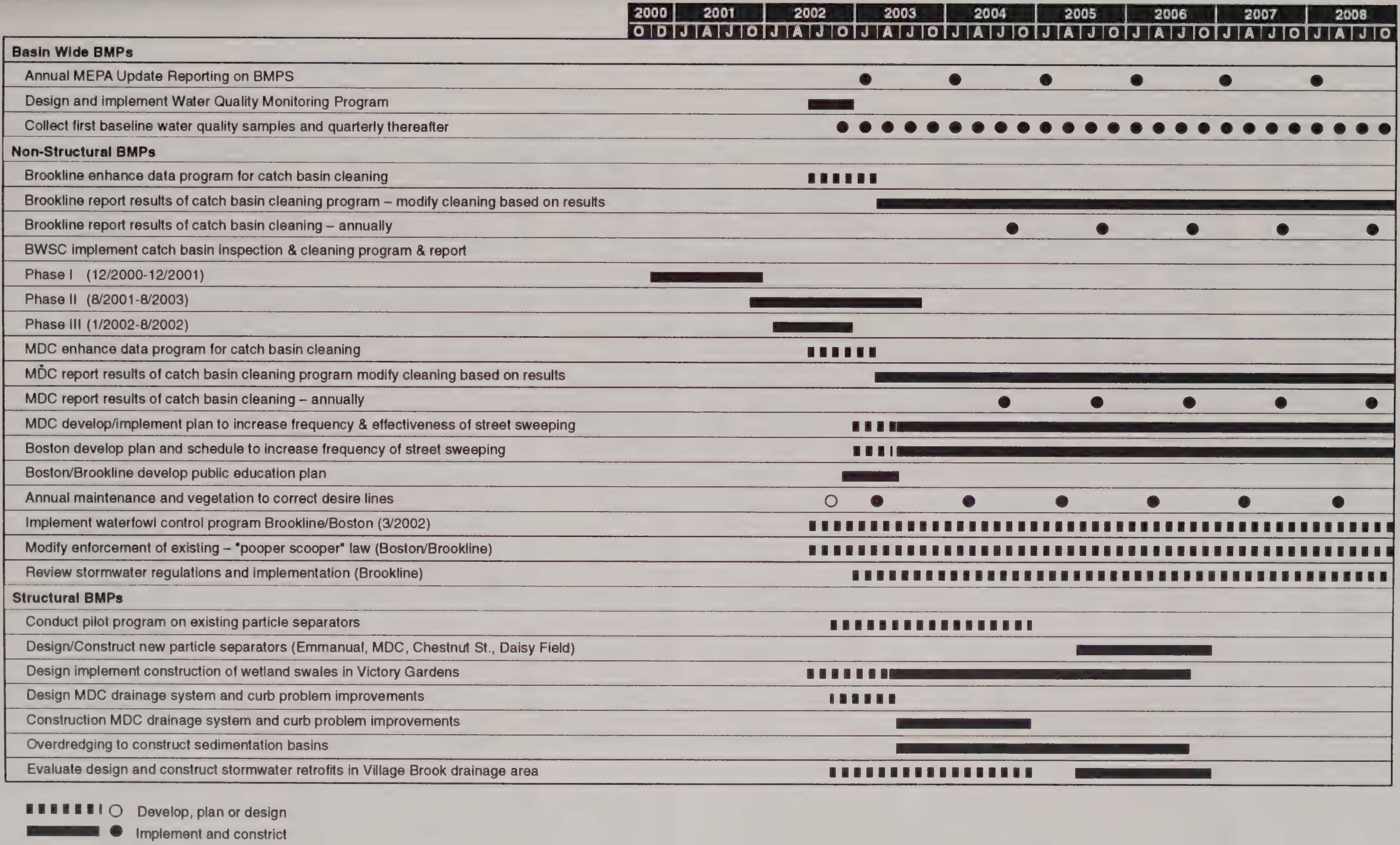


Figure 5-27
Muddy River Watershed BMP Implementation Plan

5.7.1 Basin-Wide Source Control BMPs

Basin-wide source control BMPs to be implemented or improved include the following:

- An annual water quality sampling program is to be designed and implemented beginning in 2002. Baseline water quality samples are recommended to be taken in fall 2002, after the Final EIR is approved by MEPA. Water quality samples would be taken on a quarterly basis to measure the effectiveness of the BMP program. The program would sample at 8 river locations and at 7 outfalls. A dry period, precipitation and post-precipitation sample would be collected at each site. The results of the water quality sampling program would be used to compare to the recommended goal for TSS loading for achieving the re-sedimentation target as shown in Figure 2-38. Details of this program are described in Section 8 and Appendix G. The responsibility of the water quality sampling program would be divided among the project proponents, according to watershed area.

- As discussed in Section 2.5, a major effort in the City of Boston needs to be undertaken to increase the frequency and effectiveness of their street sweeping program. The Boston Public Works Department would develop its plans in early 2003, and implement in the fall of 2003. The improvement in the plan is dependent on the results of BWSC's catch basin cleaning program , which will be completed by 2003. Once the results of the catch basin program have been analyzed, Boston would revisit the street sweeping plans.

  It is recommended that the MDC examine the effectiveness of its street sweeping program in the parkways in 2003 and implement more frequent sweeping by fall of 2003. The recommended frequency should be monthly unless analysis of sweeping effectiveness indicates otherwise.

- Increased frequency and improved tracking of scheduled catch basin cleanings and sediment removed from individual catch basins is necessary. Work has already begun on the Catch Basin Inspection and Cleaning Program for the Boston Water and Sewer Commission, with the inspection and cleaning of catch basins citywide to be completed by the end of 2003. Both Brookline and the MDC also need to enhance their data programs for catch basin cleaning, which would begin in January 2002. Brookline DPW will enhance the data collection portion of its program. It is recommended that the MDC also design and implement a data base for catch basin cleaning and enhance their cleaning program. The proponents would annually report the results of the catch basin cleaning to MEPA, beginning in 2003. The reported results can be used to modify the catch basin cleaning programs appropriately.

- Proper maintenance to address desire lines (unplanned paths) and to prevent erosion and re-sedimentation is another basin-wide source control BMP. BPRD and BPOS could address desire lines either by formalizing the pathway (applying a surface treatment such as stone dust, mulch or pavement material) or by revegetating with turf or appropriate plant materials.

Initially an inventory would be made of the areas and a determination would be made of the priorities for treatment for each area and the appropriate surface treatment. Consideration will also be made of areas that will be disturbed by construction due to the Muddy River Restoration Project. Implementation of the addressing of desire lines will take place annually over several years, beginning in the spring of 2003. Each year there will be an update of the inventory of eroded or denuded areas that need surface treatment.

- A public education program would be developed jointly by the project proponents. The public education program is proposed to educate the public on their role in litter control, cleaning up after their pets, and limiting the use of pesticides and herbicides. Development and implementation of this public education program would begin in the fall of 2002.

- A waterfowl control program needs to be implemented by Boston and Brookline. The waterfowl control program would be developed in mid-2002 to fall 2002 with implementation in 2003. The program would be evaluated biannually for its effectiveness. The waterfowl control program would be a combination of public education (i.e. signs warning pedestrians not to feed the geese) as well as regulatory actions.

- The MDC is recommended to adopt similar regulations for "Don't Dump" signs at catch basins receiving rehabilitation or new catch basins. These catch basin signs will be added to all MDC catch basins that are built as part of this project.

Brookline and Boston need to pass regulation to strengthen enforcement and increase public awareness of their existing "pooper scooper" laws, beginning in the fall of 2002 for implementation in 2003. Review any other portion of the Brookline local storm water regulations that may need strengthening. The implementation of the new enforcement procedures would begin in 2003 and implemented in 2004.

The BWSC stormwater regulations are currently adequate under the oversight of the EPA and DEP.

5.7.2 Basin-wide Treatment Control BMPs

Prior to the design and construction of any of the structural BMPs described in sections 5.7.3 to 5.7.7, a pilot program is necessary to be conducted on existing particle separators in the Muddy River watershed. This pilot program will involve collection of water quality and velocity data during storm events on existing particle separators in the basin to help determine proper design and site selection. Current particle separators show mixed results with some collecting no sediments and others obviously passing large amounts of sediments onto the river system. Both Brookline and BWSC are planning to study particle separators independent of this effort. We have carried a cost to conduct a consolidated study which could be significantly reduced if the two entities use their data as part of the recommended Muddy River plan.

In addition to the pilot data to improve design and selection of the treatment BMPs, the pilot program will include an evaluation of the potential locations of treatment BMPs in the watershed upstream of the Muddy River. Using current runoff models, locations for treatment BMPs will be evaluated to improve water quality in the basin. Treatment BMPs originally proposed by the Center for Watershed Protection would also be reviewed as part of this analysis. Estimated costs of the treatment BMPs would be prepared so selected BMPs could be constructed using the budget set aside in this DEIR.

Data collection for the pilot program would begin in fall 2002 and the results of the pilot program used in conjunction with the results of the water quality monitoring program to help design the particle separators at exact locations to be determined. Data would be evaluated and possibly more collected between 2003 and 2004 resulting in recommendations for particle separators or other structural BMPs in the basins. Design of the particle separators is expected to begin in mid-2005, with construction of the new particle separators to begin in 2006. This program would be managed by BWSC for Boston and costs shared by Brookline Public Works Department and MDC.

5.7.3 Charlesgate Area

Once the Muddy River has been dredged in the Charlesgate area, it is necessary that the City of Boston and the MDC expand on certain source control BMPs, such as street sweeping and catch basin cleaning. As mentioned in Section 2.5, a city-wide catch basin inspection, cleaning and repair program began in December 2000 and progress in this program is a significant improvement to the BMP program in Boston. Increasing the frequency and regularity of street sweeping by enforcing the ticketing and towing of parked vehicles is another BMP that is a necessary improvement in the Charlesgate area as well as the rest of the Muddy River watershed. The only drainage discharges in the Charlesgate area are from the MDC roadways and the Massachusetts Turnpike. These discharges should be monitored to determine if these agencies should add or augment treatment controls to reduce sediment discharge into the river.

5.7.4 Back Bay Fens

5.7.4.1 Source Control BMPs

In the Victory Gardens, a recommended source control BMP is to decrease the use of pesticides and herbicides. This will be achieved by educating the public (via flyers and mailings) on the dangers of pesticides and herbicides in relation to water quality and aquatic habitat and by providing information on alternative methods of pest and weed control. The public education program will be developed jointly by Boston and , Brookline, beginning in 2002 (see 5.7.1). An integrated pest management program and pesticide alternatives, such as insecticidal soap or natural bacteria, can also reduce the need for pesticides. BPRD will coordinate the public education program with the Fenway Garden Society in their annual meetings. The education program would be useful for other abutting properties also and the Fenway Garden Society may help in disseminating information. A second recommendation in conjunction with public education is to post signs stating "Tributary to the Charles River" near the Muddy River at the Victory Gardens.

Addressing of the desire lines is recommended to encourage pedestrians to stay on the established footpaths in the high foot traffic areas of the Back Bay Fens. Addressing desire lines is a BMP because it reduces erosion from pathways that are bare earth, minimizing the sediment entering the watercourse as a result of people using the bare earth paths. Desire lines will be addressed by BPRD, either by formalizing the path (applying a surface treatment such as stone dust, mulch or pavement material) or revegetating with turf or appropriate plant material to discourage us of informal paths. The addressing of desire lines will begin in the spring 2002. Evaluation of desire lines and determination of the appropriate method of addressing them will continue on an annual basis.

The reconstruction, monitoring, and maintenance of the stormwater drainage system along the MDC Roadways in the Fens, such as Park Drive, the Fenway, and Aggasiz Road is necessary because roadway drainage overflows the curb causing erosion along the banks and sedimentation of the eroded material in the Muddy River. Design and reconstruction of the drainage systems and curb in problem areas is to begin in mid-2002.

Similar to the Charlesgate area, street sweeping in the Fenway area is a BMP that needs improvement. A consideration that would assist the City of Boston in upgrading the frequency and effectiveness of its street sweeping program in the Muddy River watershed is alternative parking for residents. It is recommended that the City of Boston investigate alternative parking measures by communicating with colleges in the area. A recommended improvement to the street sweeping program would occur if the colleges would allow residents to park in a designated campus lot on the scheduled day for street sweeping in their neighborhood. Boston would develop a plan to improve the street sweeping program beginning in January 2002, with implementation in Fall 2002.

5.7.4.2 Treatment control BMPs

A vegetated swale is recommended for construction in the Victory Gardens to reduce flow velocities and to trap pollutants. A wet swale is being designed for this area as a deterrent to pedestrians. The design for this swale is to begin in 2002 with construction in 2003 to 2004 depending on the exact construction schedule. The swale is part of the capital improvement program. In order to determine the effectiveness of the swale, a single round of tests from runoff in the underground tiles should also be completed.

A particle separator is recommended for installation at the outlet of the Emmanuel College Drain to trap sediment and prevent it from entering the Muddy River. The particle separator would be designed to treat a portion of the maximum flow of 62 cfs to remove sediment from most storms and bypass excess flow from maximum storms. A second and similar particle separator for another area in the Back Bay Fens will also be constructed. The design for the particle separators will begin only after the results of the pilot program have been analyzed. The design and construction of the particle separators would be completed by 2007 and would be part of the capital improvement program. BWSC would be responsible for construction particle separators on any of its drains.

Sedimentation basins, formed by overdredging, are recommended in three areas in the Back Bay Fens. These overdredged areas would serve as low points where sediment can settle out without occupying any additional channel capacity, and can be re-dredged in the future. These areas are open water areas within the newly dredge river channel. The additional volume of sediment that is to be removed for the sedimentation basins for each area is listed in Table 5-8 and shown on Figures 5-4 and 5-5 and in greater detail in Appendix I. Overdredging will take place along with the dredging scheduled for the Back Bay Fens beginning in 2003. The sedimentation basins will be constructed as part of the capital improvement program.

Maintenance and maintenance access for all sedimentation basins is discussed in Section 8.

Table 5-8

Volumes of Sediment To Be Removed By Overdredging

Location	***Volume of Sediment To Be Overdredged (cubic yards)***
Downstream of Louis Pasteur Bridge	532
Downstream of BWSC Gatehouse 1	12,445
Victory Gardens	2,541

The design and construction of particle separators along Park Drive, the Fenway, and Aggasiz Road are recommended and would be part of the capital improvement program in 2006. The design of these particle separators will begin in 2005, after the results of the pilot program have been analyzed in 2002 to 2004. It may be practical to construct the separators in conjunction with drainage system reconstruction.

5.7.5 The Riverway

5.7.5.1 Source control BMPs

Similar to the Fens, the Riverway is a high pedestrian traffic area, and is characterized by similar problems with desire lines formed by pedestrians not using paths. Addressing the desire lines is planned to encourage pedestrians to stay on the trails. This will reduce erosion from multiple paths and minimize sediment from entering the watercourse as a result of people using desire lines. The correction of desire lines by re-vegetation is scheduled to occur in spring 2003, with annual trail maintenance to take place each spring. Evaluation of the desire lines and determination of appropriate methods of addressing them would occur each year. BPRD and BPOS would be responsible for correcting desire lines on their respective sides of the park.

A second issue in the Riverway is catch basin cleaning and maintenance. During site visits to the Riverway, MDC catch basins filled with sediment were observed. One of these was located on the Netherlands Road Bridge, near the border of Boston and Brookline. It is recommended that the MDC improve their catch basin cleaning program citywide, because full catch basins are not just limited to the Riverway. In order to do so, the MDC has to increase its budget or get a private contractor to accomplish the recommended program because they are not accomplishing this work with current resources. Recommended improvements include increasing the frequency of catch basin cleaning by the MDC and upgrading the equipment used to clean the catch basins. An automated system to track the schedule of catch basin cleaning and to record the amount of sediment removed from each catch basin is also recommended. MDC should develop a plan for enhancing their data program for catch basin cleaning, beginning in 2003 to be consistent with the BWSC and Brookline programs. The results of the catch basin cleaning program would be reported to MEPA, beginning in 2003. The reported results can be used to modify the catch basin cleaning program if necessary. As discussed earlier under Basin Wide Source Control both Boston and Brookline would also improve catch basin cleaning in areas adjacent and contributory to the Riverway.

Another source control BMP is the correction of situations in which roadway drainage from the MDC parkways overflows the curb and erodes the slope in the parklands, with the result of sedimentation in the river. The problems have several causes including undersized and/or clogged drainage systems, poor soils and/or cracked/leaking pipes leading to irregular settling of pavement and curbing, and the splashing of rain runoff in the roadway gutter by passing cars. Repairs would be made by correcting unsuitable foundation problems and repair or replacement of catch basins and storm drain with subsequent pavement repairs. Each failed location will be examined to determine the proper repair. Design of repairs will take place in 2002, while construction of the repairs will be part of the capital project.

5.7.5.2 Treatment Control BMPs

Three open water areas are proposed to be overdredged to create sedimentation basins in the Riverway. These areas and volume of sediment are:

Upstream of Riverway Culvert	1,000 c.u. yards
Downstream of Netherlands Road	284 c.u. yards
Upstream of Brookline Avenue	1,440 c.u. yards

These areas are shown on Figures 5-17 and 5-18 and in more detail in Appendix I. Overdredging will take place in conjunction with the dredging of the river, which is scheduled between 2003-2005.

The overdredging would result in sedimentation basins that provide additional channel capacity for re-sedimentation when it does occur. While the goal of the BMP plan is to eliminate re-sedimentation, some re-sedimentation will continue, given the size of the watershed, the evolution and improvement of existing BMPs will take time. No plan can realistically capture 100% of sediment.

5.7.6 Leverett Pond

5.7.6.1 Treatment Control BMPs

The largest input to the Muddy River is the Village Brook drain, which enters the watercourse at Leverett Pond. As part of the Lower Charles River Basin Retrofit Inventory, prepared for the EPA by the Center for Watershed Protection, the Village Brook drainage area was evaluated for possible stormwater retrofits. CDM and its subconsultant reviewed the Center for Watershed Protection's report and determined that while some of the retrofits are appropriate there are implementation issues. These alternatives would be further evaluated after the results of the pilot program on particle separators have been analyzed. The value of these items has been estimated and a sum of money has been set aside to be used for structural BMPs once it is determined which locations are appropriate for particle separators. The selected retrofits would be designed in 2005 with construction to begin in early 2006 and would be the responsibility of the proponents.

A particle separator is recommended for installation at the Daisy Field outfall culvert. A particle separator will be installed to trap some of the sediment that currently enters Leverett Pond and the Muddy River via the Daisy field drain. This particle separator would be designed to treat a portion of the maximum flow of 28 cfs to remove sediment from most storms and bypass excess flow from the maximum storms. The BWSC would be responsible for the monitoring and maintenance of this particle separator and construction would be part of the capital improvement program. The design for this particle separator should occur after the results of the pilot program have been analyzed, or in 2004, with construction to occur in spring 2006.

A sedimentation basin, formed by overdredging, is also recommended In Leverett Pond as a treatment control BMP. The sedimentation basin would provide additional channel capacity for re-sedimentation when it does occur. The total amount of sediment that is to be overdredged in Leverett Pond is 2063 cubic yards and is shown on Figure 5-18 and in Appendix I. The overdredging area is an open water area within Leverett Pond. The overdredging is scheduled to take place when the rest of the Muddy River is dredged, in 2003to 2006 depending on the ACOE construction schedule, and would be part of the capital improvement program.

5.7.7 Willow Pond

5.7.7.1 Source Control BMPs

Proper maintenance of the footpaths around Willow Pond and also at Wards Pond is needed to prevent further erosion of this footpath and to minimize sediment entering the pond (and therefore the Muddy River system) as a result of pedestrians and bikers using desire lines. Addressing these desire lines will reduce erosion from pathways that are bare earth. Desire lines will be addressed by BPRD, either by formalizing the pathway (applying a surface treatment such as stone dust) or by revegetating with turf or appropriate plant materials to discourage use of the informal paths. In some locations planting and promoting growth of tall vegetation would minimize the creation of desire lines by footpath users. The addressing of desire lines will begin in spring 2003. Evaluation of desire lines and determination of the appropriate method of addressing them will continue on an annual basis.

5.7.7.2 Treatment Control BMPs

The Chestnut Street drain is a significant source of sediment to Willow Pond and therefore to the Muddy River. Field reconnaissance as part of this project shows a large sandbar in very close proximity to the outlet of the Chestnut St. drain. A particle separator is recommended for installation at the outlet of the Chestnut St. drain to trap some of the sediment before it enters Willow Pond. This particle separator is proposed to be designed only after the results from the pilot program on particle separators have been analyzed. Brookline would be responsible for this BMP. The design is scheduled to take place in 2005 with consideration of the design by the regulatory agencies in 2006, and construction scheduled for 2006.

Another treatment control BMP that is recommended in Willow Pond is a sedimentation basin formed by overdredging. Removing an additional volume of sediment during the dredging process will leave capacity for future re-sedimentation in the pond. The total amount of sediment to be removed by overdredging in Willow Pond is 842 cu. Yards and is shown in Appendix I. The overdredging is scheduled to take place when the rest of the Muddy River is dredged, between 2003 and 2006 depending on the ACOE schedule.

5.7.8 Enforcement and Monitoring of Best Management Practices

Proper enforcement and monitoring of best management practices is a critical factor in their effectiveness. Non-structural BMPs are often the most difficult to enforce and monitor, and rely on citizen involvement. For example, litter control and "pooper scooper" ordinances are difficult to enforce and rely solely on citizens cleaning up aftertheir pets.

Similarly, reduction in herbicides and pesticides is a simple means of controlling pollutants entering the water but relies heavily on public education efforts. An informed public greatly eases the burden on municipalities in this area.

Catch basin cleaning is another BMP where ongoing maintenance is a significant issue. For example, the Boston Water and Sewer Commission currently spends millions of dollars on catch basin cleaning and inspection, but unless catch basins continue to be cleaned on a regular and frequent basis, their effectiveness on reducing solids deposition in the Muddy River is limited.

The responsibility for funding, enforcement and monitoring of BMPs rests on the project proponents. The Memorandum of Understanding (MOU) among all parties and the Annual Update report to MEPA are the two vehicles that will ensure that BMPs will be completed. The MOU delineates the responsibilities of the signing parties to implement and fund BMPs including ongoing maintenance. The document provides an enforceable agreement to meet these obligations. Parties to the MOU have proposed their actions in the DEIR that would be the basis for delineating responsibilities.

The purpose of the Annual Update (see Section 9) is to inform the Secretary and the public on the process of project implementation and monitoring, as well as the effectiveness of mitigation and replanting. The annual update to MEPA is a crucial element of the BMP plan because it provides a method of reporting the progress on the implementation and effectiveness of the BMP plan to all parties of the MOU.

The major components of the BMP plan which should be addressed in the Annual Update to MEPA include the following:

- Results of water quality sampling program (sampled quarterly-reported annually);
- Results of pilot program on particle separators (initial year);
- Results of catch basin cleaning program (Brookline, Boston and MDC, annually); and
- General report addressing new BMPs which were implemented within the year and a measure of the effectiveness.

5.7.9 Costs for Best Management Practices

BMPs will be implemented in several ways as discussed under the preceding paragraphs in Section 5.7. BMPs will be implemented as part of the initial capital construction program (i.e. sedimentation basins) as future capital or planning investments (i.e. public education), or as part of annual maintenance programs (such as path maintenance). Future capital or planning investments are those projects that require a one-time appropriation for a capital or planning project. Annual programs include items that recur each year and depending on the funding agency's fiscal guidelines, could be included in maintenance or as part of annual capital programs. Costs for all recurring BMP costs are included in the Operator & Maintenance section 8 since they recur annually. In this way, the annual value of work can be estimated. Agencies may choose to fund some of the annual costs as annual capital costs.

Cost in this section only include one-time capital costs, whether they are capital or planning items.

The capital costs for all BMPs are included in Table 5-9. Elements of some BMPs will be conducted as one project (i.e. pilot program for particle separators) and the costs will be assigned to proponent parties on a proportional basis. The cost of the shared elements will be split either on a percent of park area owned within the project area or even split between proponents. The percentages for park area splits are as follows:

City of Boston	25%
Town of Brookline	67%
MDC	8%

The total initial capital costs for BMPs is $11,256,000 with an additional $250,000 in addition to planning and minor capital programs. Approximately $30,000 (BWSC catch basin inventory and preventative maintenance program) of the additional $250,000 has already been funded so that only $220,000 of new funds would be required.

New funds not already committed for BMPs for Table 5-9 are as follows:

City of Boston Total	$120,000
Town of Brookline Total	$90,000
MDC	$40,000

Capital costs for BMPs included in the initial construction program are repeated on Table 5-10 as part of overall initial construction costs.

Operation and maintenance or annual costs for BMPs are included in Section 8.

5.8 Construction Phasing and Schedule

Construction phasing of the project will be dependent on the sources of funding and timing of when funds can be appropriated and obtained. Funding sources and amounts are currently to be identified and contacted for areas other than Charlesgate. Funding for the Charlesgate portion of the project has been identified and the project has been designated by the Secretary of the Environment to proceed if sufficient information is included in this DEIR to address the environmental issues.

The Charlesgate portion of the project which includes dredging in the Charlesgate area and removing several obstructions under bridges between Ipswich Street and the

Best Management Practice (BMP)	Responsibility	Type of BMP	Initial Capital Program	Total Boston	Total Brookline	MDC	Total Planning / Capital
Basin-Wide Source Control BMPs							
Annual water quality sampling program	Administered centrally with shared cost	Non-structural		Annual expenditure - see Section 8			
Improved street sweeping program	Boston PWD	Non-structural		Annual expenditure - see Section 8			
	Brookline DPW	Non-structural					
	MDC	Non-structural					
Institute catch basin cleaning / tracking program	BWSC	Non-structural		$30,000	$0		$30,000
	Brookline DPW	Non-structural			$10,000		$10,000
	MDC	Non-structural				$40,000	$40,000
Trail maintenance	BPRD	Non-structural		Annual expenditure - see Section 8			
	Brookline POS	Non-structural					
	MDC	Non-structural					
Public education program	Administered centrally with shared cost	Non-structural		$20,000	$20,000	$0	$40,000
Waterfowl control program	BPRD	Non-structural		Annual expenditure - see Section 8			
	Brookline POS	Non-structural					
Catch basin labeling program	MDC	Non-structural		Annual expenditure - see Section 8			
Review and strengthen park and stormwater regulations	BPRD	Non-structural		Annual expenditure - see Section 8			
	Brookline POS	Non-structural					
Basin-Wide Treatment Control BMPs							

Table 5-9
Summary of Capital Costs for Watershed BMPs

Best Management Practice (BMP)	Responsibility	Type of BMP	Initial Capital Program	Total Boston	Total Brookline	MDC	Total Planning / Capital
Pilot particle separator program and basin BMP evaluation	Administered centrally with shared cost	Non-structural		$65,000	$60,000	$0	$125,000
Back Bay Fens - Source Control BMPs							
Public education program for pesticide / herbicide /fertilizer use	BPRD	Non-structural		Annual expenditure - see Section 8			
Correction of desire lines with revegetation	BPRD	Non-structural		Annual expenditure - see Section 8			
Repair curb settings along roadways	MDC	Structural	$297,000				
Back Bay Fens - Treatment Control BMPs							
Vegetated swale in Victory Garden	Part of capital program	Structural	$112,000	$5,000	$0	$0	$5,000
Design and construct particle separator at Emmanuel College Drain	BWSC	Structural	$301,000				
Design and construct sedimentation basins in river	Part of capital program	Structural	$4,885,000				
Design and construct particle separator for MDC storm drains	MDC	Structural	$301,000				
Riverway - Source Control BMPs							
Correction of desire lines with revegetation	BPRD	Non-structural		Annual expenditure - see Section 8			
Repair curb settings along roadways	MDC	Structural	$296,000				

Table 5-9
Summary of Capital Costs for Watershed BMPs

Best Management Practice (BMP)	Responsibility	Type of BMP	Initial Capital Program	Total Boston	Total Brookline	MDC	Total Planning / Capital
Riverway - Treatment Control BMPs							
Design and construct sedimentation basins in river	Part of capital program	Structural	$481,000				
Leverett Pond - Treatment Control BMPs							
Potential particle separators or other treatment controls	Brookline DPW	Structural	$3,148,000				$0
Design and construct particle separator at Daisy Field Drain	BWSC	Structural	$302,000				
Design and construct sedimentation basins in river	Part of capital program	Structural	$575,000				
Willow Pond - Treatment Control BMPs							
Design and construct particle separator at Chestnut Street Drain	Brookline DPW	Structural	$323,000	$0	$0		$0
Design and construct sedimentation basins in river	Part of capital program	Structural	$235,000				
			$11,256,000	$120,000	$90,000	$40,000	$250,000

Note: MDC BMPs are proponents recommended items for MDC participation.

Table 5-9
Summary of Capital Costs for Watershed BMPs

Charles River has funding set aside for design and construction. Bidding is expected to start in the spring of 2002 upon receipt of the Secretary's certificate on the DEIR. Construction should proceed after award and be completed by late 2002.

Construction phasing for planning purposes on the remainder of the project is assumed to be a single construction project. The single project assumption would allow award of a contract and progress would be dependent on the appropriated funding each year. This method of construction would simplify construction award and not require multiple awards based on funding individual contracts. Under these circumstances the bidding is not expected to occur until the Secretary issues a certificate on the final EIR. Assuming a Certificate on the Final EIR is issued in winter 2002, the bidding could begin in winter 2002 and construction started in early 2003 with completion in late 2005.

A summary of the proposed schedule is as follows:

Bid Charlesgate	Spring 2002
Start Charlesgate Construction	Spring 2002
Complete Charlesgate	Winter 2002
FEIR Certificate	Winter 2003
Bid Muddy River	Winter 2003
Start Muddy River Construction	Spring 2003
Complete Muddy River	Winter 2006

5.9 Cost Estimate

Capital cost estimates of the proposed project discussed above are provided on Table 5-10. Costs for the maintenance and monitoring of the project are discussed in Section 8. The capital cost components are anticipated to be constructed using a variety of funding sources and administered under the Memorandum of Understanding by the joint project proponents. Other cost elements of the project are anticipated to be borne by the local community or agency that owns the facilities and are not part of the project capital program.

Capital costs have been estimated based on the conceptual design plans prepared as part of this study. The estimate is prepared using the Engineering News Record (ENR) index of 7009 for November 2000. Construction costs are based on local experience for projects of a similar nature. Sediment disposal costs are based on the experience of the Central Artery bidders for similar disposal of materials.

Table 5-10

MUDDY RIVER RESTORATION PROJECT
CONSTRUCTION COST ESTIMATE BASED ON CONCEPTUAL DESIGN
(Costs Rounded to Nearest $1,000)

	Quantity (cy)	Cost
Charlesgate		
Dredging	4,000	$238,000
Replacement or mitigation planting*		$656,000
Disposal - Non RCRA	4,000	$550,000
Subtotal construction estimate		$1,444,000
Design Development / contingencies		$423,000
Subtotal		$1,868,000
Escalation 2.5%		$47,000
Total Charlesgate		$1,915,000
Back Bay Fens		
Dredging / grading / phragmites removal	103,435	$3,470,000
Replacement or mitigation planting		$2,162,000
Disposal sediments / phragmites -Non RCRA	59,623	$8,151,000
Disposal sediments / phragmites - RCRA	43,812	$10,896,000
Fens Bridge		$514,000
Daylight Upper Fens Pond to Back Bay		$1,014,000
Brookline Avenue Culvert / gatehouse		$3,961,000
Daylight Sears Parking lot		$1,672,000
Riverway Culvert		$2,535,000
Subtotal construction estimate		$34,375,000
Design Development / contingencies		$9,174,000
Subtotal		$43,549,000
Escalation 8%		$3,484,000
Total Back Bay Fens		$47,033,000
Riverway		
Dredging / grading / phragmites removal	28,477	$945,000
Replacement or mitigation planting		$1,762,000
Disposal sediments / phragmites -Non RCRA	28,477	$3,903,000
Historic islands		$30,000
Subtotal construction estimate		$6,639,000
Design Development / contingencies		$1,738,000

Table 5-10

MUDDY RIVER RESTORATION PROJECT
CONSTRUCTION COST ESTIMATE BASED ON CONCEPTUAL DESIGN
(Costs Rounded to Nearest $1,000)

	Quantity (cy)	Cost
Subtotal		$8,378,000
Escalation 8%		$670,000
Total Riverway		$9,048,000
Leverett Pond		
Dredging	21,788	$764,000
Replacement or mitigation planting		$775,000
Disposal sediments -Non RCRA	21,788	$2,996,000
Subtotal construction estimate		$4,535,000
Design Development / contingencies		$1,138,000
Subtotal		$5,672,000
Escalation 8%		$454,000
Total Leverett Pond		$6,126,000
Willow Pond		
Dredging / grading	5,054	$177,000
Replacement or mitigation planting		$523,000
Disposal sediments -Non RCRA	5,054	$695,000
Babbling Brook		$120,000
Subtotal construction estimate		$1,515,000
Design Development / contingencies		$426,000
Subtotal		$1,942,000
Escalation 8%		$155,000
Total Willow Pond		$2,097,000
Ward's Pond		
Dredging / grading	15,565	$546,000
Replacement or mitigation planting		$160,000
Disposal sediments -Non RCRA	14,008	$1,926,000
Disposal sediments -RCRA	1,557	$292,000
Subtotal construction estimate		$2,924,000
General conditions		
Design Development / contingencies		$691,000

Table 5-10

MUDDY RIVER RESTORATION PROJECT

CONSTRUCTION COST ESTIMATE BASED ON CONCEPTUAL DESIGN

(Costs Rounded to Nearest $1,000)

	Quantity (cy)	Cost
Subtotal		$3,615,000
Escalation 8%		$289,000
Total Ward's Pond		$3,904,000
Engineering cost		$8,900,000
Grand Total with out structural BMPs		$79,023,000
Structural BMPs		
Sediment Weirs at Tannery and Village Brooks		
Sediment Basins Dredging	21,147	$741,000
Sediment Basins Disposal -Non RCRA	17,717	$2,436,000
Sediment Basins Disposal - RCRA	3,430	$643,000
Structural BMPs based on results of initial BMP implementation		$1,947,000
Correct MDC curb /catch basins		$367,000
Wetland swale at Victory Gardens		$70,000
Three particle separators		$559,000
Particle separator at Chestnut St.		$200,000
Design Development / contingencies		$1,975,000
Escalation 8%		$217,000
Engineering cost		$2,100,000
Total Structural BMPs		$11,255,000
Project Total with BMPs		$90,278,000
Program Management Costs		$800,000
Project Total with BMPs and Management		$91,078,000

* In disturbed areas including staging areas

6

Section Six

Section 6

Assessment of Impact/ Environmental Consequences

This section contains the description of anticipated environmental impacts of the proposed project for each of the project areas (i.e., Charlesgate, Back Bay Fens, etc.). The text is purposely redundant to provide a more complete understanding of the impacts within each area.

6.1 Assessment of Environmental Impacts in the Charlesgate Area

Construction activities that are proposed within the Charlesgate Area include:

- The formation of one staging area for dredging equipment including belt filter presses and other appurtenances,
- The removal of waterway obstructions,
- The dredging and removal of approximately 3,300 cubic yards (cy) of accumulated sediment and debris from the Charles River culvert to the Richardson Bridge,
- The restoration and re-vegetation of the staging area upon completion of the work,
- The planting of new vegetation,
- The repair or replacement of worn pathways, and
- Installation of new park benches and waste barrels.

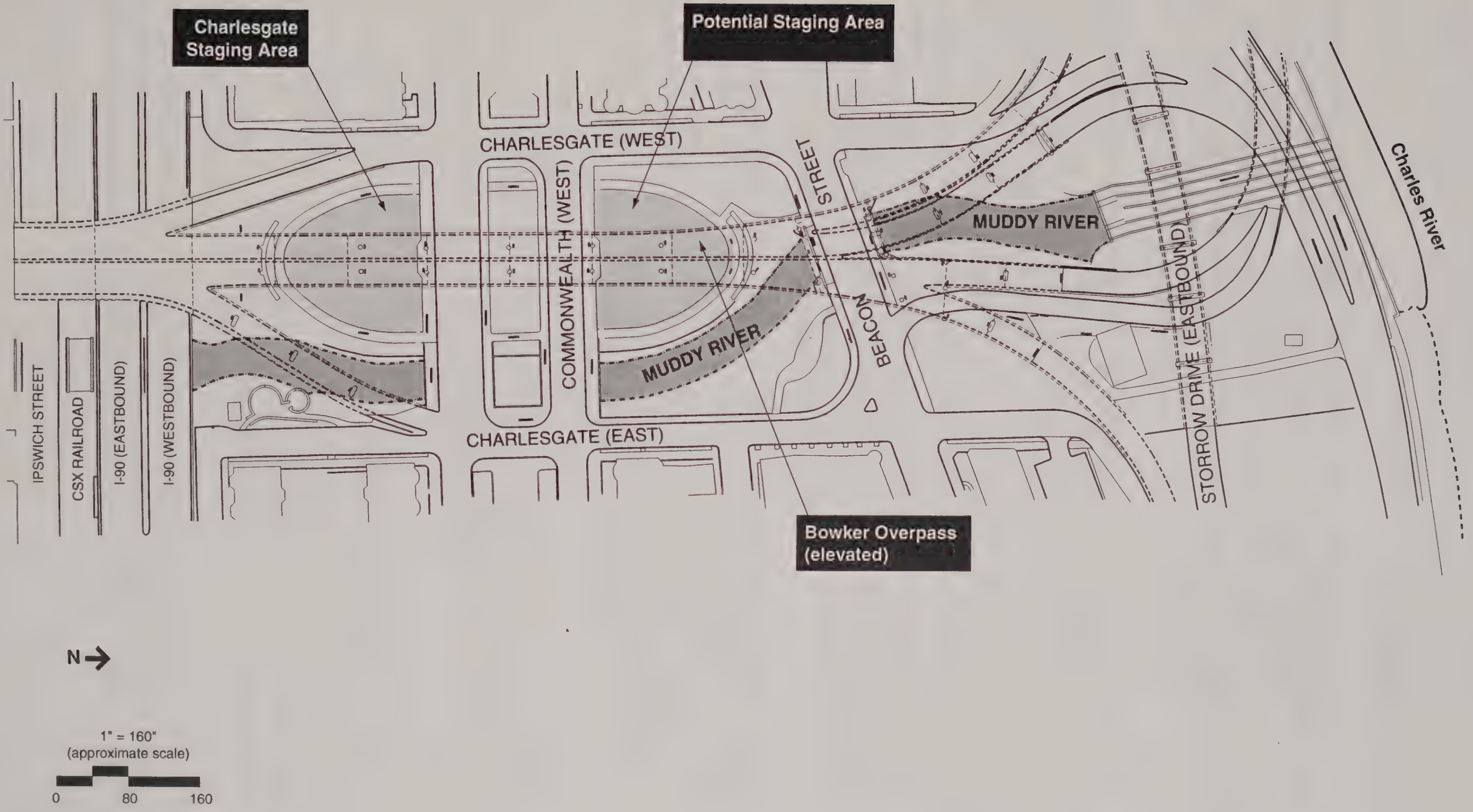
The proposed construction and re-vegetation activities are shown in the Preliminary Design Report that is included in Appendix I.

The types of impacts that have been analyzed include those to the physical (hydrology, sediment, staging areas, etc), chemical (water quality), biological (benthic macroinvertebrates, insects, fish, birds, vegetation, etc.) and human (pedestrian movement, traffic, staging areas, park use, etc.) environmental elements.

6.1.1 Physical Environmental Features

Environmental enhancement is one of the cornerstones of the Muddy River Project. In the Charlesgate Area, this includes the enhancement of the parkland following a short-term construction period.

The physical environmental features in the Charlesgate Area will be disturbed temporarily during construction. As shown in Figure 6-1, approximately 50,000



CDM Camp Dresser & McKee Inc.

Figure 6-1
Charlesgate Area

square feet(sf) of the Charlesgate Area will be used for a temporary staging site. The site will contain sedimentation tanks, pumps, coagulant polymer feed systems, belt filter presses, water filters, conveyor belts for truck loading, a field office, and limited construction personnel parking. Excluding street locations where cranes will be used for lifting dredging equipment and conducting debris removal, construction activities will be limited to the staging area. Truck queuing will occur off-site and the trucks will be called to the site by radio/telephone.

The staging area presently contains both bare and grassed terrain, some worn and drab park benches, minimal shrubs, and pathways in need of considerable repair and/or replacement. No vegetated wetlands are present in this area. Between the Ipswich Street Bridge and the Richardson Bridge, there is a narrow band of *Phragmites* along the east side of the Muddy River that is growing on a root mat that is on top of the rip-rap. The sides of the Muddy River through the Charlesgate Area consist of rip-rap and concrete as well as a number of large roadway and railroad bridges. It is planned that the Charlesgate staging area would be used from nine to 13 months, depending on the time of year it is closed and can be re-vegetated. At the conclusion of the dredging at Charlesgate, the revegetation will be temporary. These staging sites are expected to be used again during Back Bay Fens dredging, and the sites will be permanently rehabilitated at the end of that construction.

There will be extensive temporary piping for the hydraulic dredging will be placed through the park system. The piping will be placed in a manner that does not intrude with pedestrians using the paths. When paths and roadways need to be crossed, the pipes will be placed in shallow trenches and covered with asphalt / stone dust. However, in order to minimize the amount of traffic disturbance, the pipes will be laid through the existing culverts and bridges whenever possible.

6.1.1.1 Hydrology

As discussed in Section 4.2.1.1, there are physical obstructions to the flow of water in the Charlesgate Area. These include the remains of an underwater weir, sediment accumulation, and debris. The goal of dredging the Muddy River through the Charlesgate Area is to improve the hydraulic capacity.

The hydraulic benefit of the proposed improvements in the Charlesgate Area is important not only for this reach, but also for the upstream reaches of the Muddy River. The model simulation (described in more detail in Appendix E) indicates that improvements slightly lower the maximum hydraulic grade line (HGL), or water level, during the October 1996 storm in the Charlesgate Area. Figure 6-2 shows the maximum water levels in this reach during the October 1996 storm for the existing conditions and the improved conditions.

The decrease is most evident at the Ipswich Street Bridge, where the proposed improvements lower the water elevation about 1.1 ft from about 11.6 ft BCB during the existing conditions to about 10.5 ft in the improved condition. While the rest of

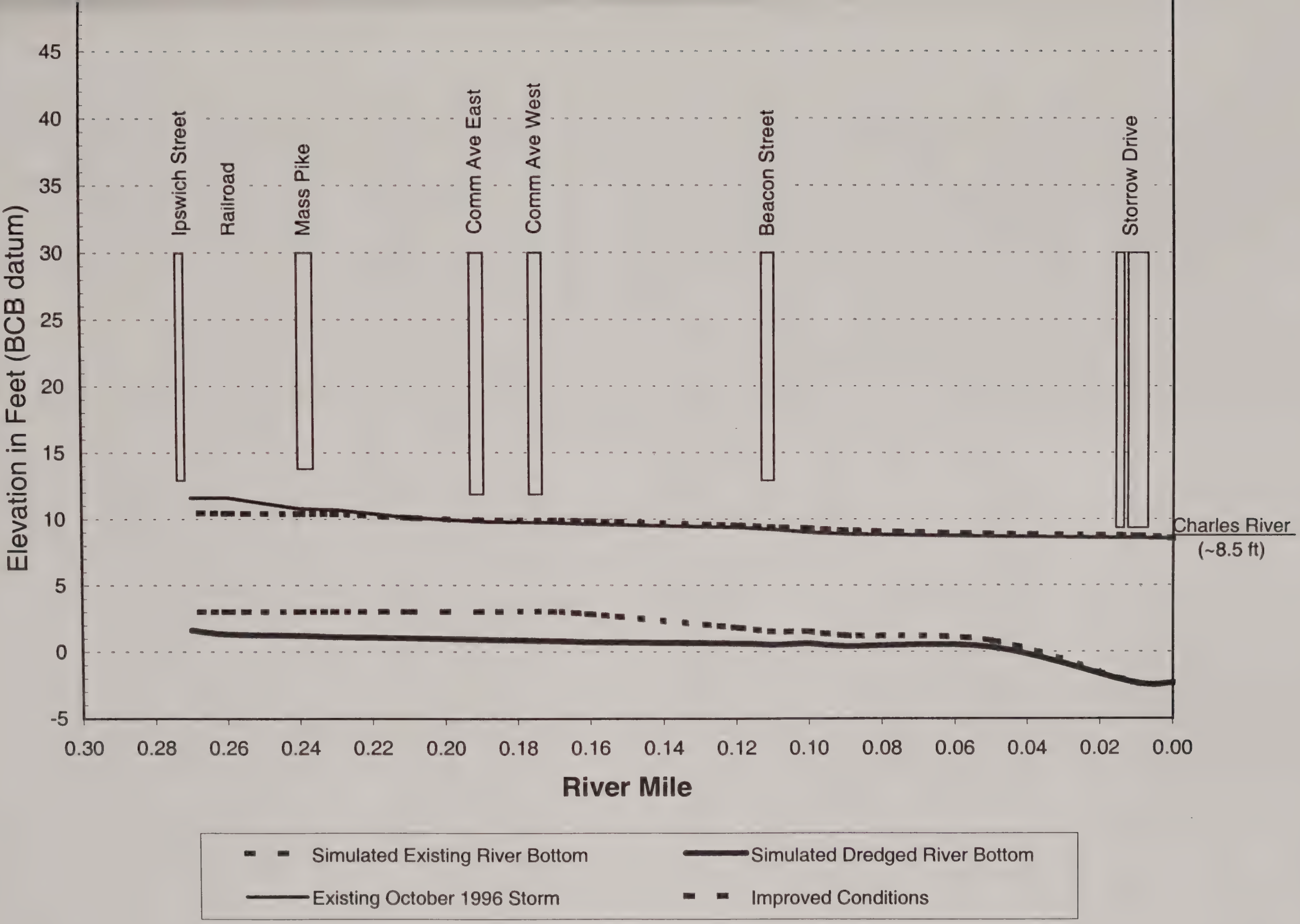


Figure 6-2
Peak Hydraulic Grade Line - October 1996 Storm
Existing and Improved Conditions - Charlesgate Area

the reach, downstream to the Charles River, does not appear to be dramatically reduced, it is important to note that the capacity of this reach is greatly increased from about 1030 cfs during the existing conditions to about 1620 cfs predicted in the improved conditions. This increase in capacity, along with other improvements upstream, allow for more significant water level reductions in upstream locations, as described in later sections.

6.1.1.2 Sediment Quality

The sediment that has accumulated in the Charlesgate Area (approximately 3,300 cy) consists of organic silt, fine to coarse sand and gravel with some bricks, wood, concrete, glass, etc. The native underlying material consists of grey silt and sand and some gravel (i.e., the remains of an estuary). Collectively, the analytical results were lower in concentration than the other areas. The sediments have been found to contain volatile petroleum hydrocarbon compounds (VPH) and petroleum odors were noted in the sample at one of the locations (see Appendix F - Sediment Characterization). The presence of petroleum hydrocarbons in the sediment is consistent with urban drainage and will not require mitigation as a separate activity. The sediments will have to be handled and disposed as contaminated sediments as described in Section 5. Accumulated sediments will be removed to a depth of four feet. This will result in an increase in river flow capacity as well as a slight improvement of sediment quality. The levels of phosphorus in the fill sediment could be the result of particulate bound or dissolved phosphorus introduced via runoff and/or stormwater discharges containing animal and waterfowl fecal matter or from point source discharges in the area.

6.1.1.3 Water Quality

The water quality of the Muddy River in the Charlesgate Area is influenced by the quality of upstream water. While no specific test results were collected for this short segment, water quality exceedances are expected for fecal coliform bacteria and dissolved oxygen based on samples of the immediate upstream segment. The river also is enriched with nutrients, which enhance algae and aquatic plant growth as is evident by the visible algal growth in this segment this summer. More complete water quality data is included in Appendix G.

Long-term and short-term impacts to water quality will occur during the life of the Muddy River Project. The short-term negative impacts to water quality will be mitigated to a large extent by construction mitigation measures that are described in Section 7.0. Although much attention has been given to the short-term impacts to water quality from construction activities, one cannot loose sight of the significant and beneficial long-term impacts that will be derived from the Project. The removal of contaminated sediment will reduce sediment oxygen demand, improve dissolved oxygen and decrease nutrient and contaminant cycling from the sediments to the water. To enhance the long-term water quality of the Muddy-River, a Best Management Practices (BMP) program (see Section 5.7- Best Management Practices), and a water quality monitoring program (see Section 7.0- Environmental Mitigation Plan) will be implemented.

The long-term impacts to water quality will be beneficial in that:

- The removal of the sediment will increase the flood flow capacity of the River,
- The removal of the contaminated sediment will enhance the quality of the River bottom for colonization by benthic organisms,
- The volume of the aquatic habitat will be substantially increased,
- The spawning habitat for fish will be improved,
- There may be an increase in the migration of anadromous fish, and
- The overall quality of the aquatic/riparian/upland habitat and its diversity will also be substantially improved.

During construction there will be several project- related sources of water that will impact the Muddy River water quality temporarily. These sources include:

- Staging area runoff,
- Turbid water at the dredge and debris removal locations and floating debris,
- Return water from the dredging and the belt filter presses processes.

Staging Area Runoff

In order to provide a workable surface, it is expected that the Contractor will form the staging area by placing a layer of crushed stone over the existing ground. In this manner the compaction of the underlying soil and erosion will be minimized. Runoff will be controlled and the Contractor will be required to submit a Stormwater/Dewatering Pollution Prevention Plan (S/DPPP) for approval by the Project, The Department of Environmental Protection (DEP) and the Boston Conservation Commission (BBC) before construction is allowed to proceed. The S/DPPP will contain an Erosion and Sedimentation Control Plan and a Spill Prevention Control and Countermeasure Plan for each staging area (see Section 7.0 - Mitigation Measures).

Turbid Water From Dredging and Debris Removal

There will be a certain amount of unavoidable turbidity that is generated at the dredge site and locations where excavators must remove debris. This impact will be limited in duration, and due to the extremely low flow volume of the Muddy River, the lateral extent of this impact will be limited. Wherever possible, the dredging area will be separated from that portion of the Muddy River where water is flowing by silt curtains in order to contain any turbidity. The monitoring of turbidity in Hardy Pond during hydraulic dredging operations indicated that there was minimal release of turbidity from the cutter head. For the purpose of establishing a limitation on the suspended solids that are generated from the dredging itself, it is proposed that the in-stream suspended solids not exceed 200% of background within 200 feet of dredging.

There is a narrow band of *Phragmites* along the east bank of the Muddy River between Ipswich Street and the Richardson Bridge. The *Phragmites* is growing on root mat that is on top of the rip-rap bank. In order that the removal of this *Phragmites* does not delay the Charlesgate dredging as the scope and document for the Final EIS/R is being produced, it is proposed that this *Phragmites* be removed at the time the Back Bay Fens is being dredged. The removal of the *Phragmites* will be conducted in a manner that is similar to that as described in Section 6.2.1.3.

Return Water from the Dredging and the Belt Filter Presses.

The most efficient procedure to remove and treat the sediment for landfill management will be through the use of hydraulic dredging methods. The hydraulic dredging method includes a dredge that floats on pontoons and includes pumps that take in water through a rotating auger that cuts into the sediment. This results in the entrainment of the sediment with water. The water, therefore, serves as the transport medium for the sediment.

From the dredge, the sediment slurry will be pumped to the staging area where it will be treated with an environmentally acceptable polymer and filtered through a belt filter press. The polymer enhances the separation of water from sediment and the result will be a high solids content filter "cake" that will be loaded into truck by a conveyor. The low moisture filter cake will be removed from the site and transported to a suitable management/disposal facility. This water/sediment treatment process will produce a flow of water that will equal the amount of water that is pumped at the dredge. This return water will be settled and filtered through a fine mesh mechanical filter prior to being returned to the river.

The return water is expected to contain a total suspended solids (TSS) concentration of 50 milligrams per liter (mg/l) and a maximum daily limit of 100 mg/l. In order for the Contractor to receive approval to proceed with the work, a Dredged Material Management Plan (DMMP) will be prepared and submitted for approval by both the DEP and the Boston Conservation (BCC). Water quality monitoring of the return water, as well as that in the Muddy River, also will be implemented. Further details on the outline of the DMMP are contained in Section 7.0 - Environmental Mitigation Plan.Best Management PracticesAlthough specific BMP measures are not proposed for the Charlesgate Area, the water quality in the Charlesgate Area should be enhanced as the result of upstream measures. In addition, the Boston Water and Sewer Commission (BWSC) is currently working to remove sediment from the Stony Brook Conduit which ultimately will mitigate impacts of overflows in the Back Bay Fens. The BWSC is also implementing the city-wide Boston Catch Basin Maintenance Program that will also have a positive impact on the water quality in the Charlesgate Area.

6.1.2 Biological Environment

The proposed Muddy River Project will result in the ultimate enhancement of the biological environment. These include upland vegetation, wetlands, and aquatic and wildlife resources. However, in the course of conducting the dredging, construction and restoration work, there will be temporary disturbances to the biological resources. The short-term and long-term impacts to the biological resources are included in the following sections.

6.1.2.1 Upland Vegetation and Horticultural Resources

The existing vegetation adjacent to the river and in the staging areas will be impacted. The removal of invasive vegetation, volunteer bushes and trees will be required to accomplish the work of this project. The Charlesgate staging area will take approximately 50,000 sf of parkland. The staging area will be utilized for approximately nine to 13 months, depending on the time of year it is closed and can be re-vegetated. At the end of Charlesgate dredging, the staging area will be temporarily restored. These areas are expected to be reused during the Back Bay Fens dredging and when the second use is complete, the staging areas will be rehabilitated according to the Preliminary Plans in Appendix I. In addition, the project plans call for the removal of Japanese knotweed that is growing in the Charlesgate area. The upland vegetation adjacent to the project areas, and upland vegetation within staging areas and access points, will be protected to their drip line, pruned, and fertilized as a means of minimizing impact to them. During construction, vegetation close to the contractor's work area will be protected with chain link fencing as required. It does not appear structures will be close enough to operations to need protection; however, if field conditions and contractor's operations warrant protection, it will be added. The protected areas will be restored in kind as required post-construction.

The bank restoration and re-vegetation process will be staged such that the extent of bare ground will be minimized at any point in time. Silt fencing will be placed and maintained along all areas to be disturbed. As soon as bank re-grading work in as area is completed, the soil in the area will be tilled and aerated and will either be sodded or mulched with pine bark in advance of the planting of vegetation. Sod will be pegged into the ground on slopes greater than 3:1. The wetland shelf will also be planted as soon after re-grading as possible. When a staging area is to be restored, the crushed stone base will be removed and the loam ground restored. The surrounding silt fencing, however, will remain until grass is growing. Only then will it be conducted by hydromulching. In the event that a staging area is to be closed outside of the growing season, the crushed stone base, site security and siltation fencing will remain in place until the next growing season. Complete site restoration will be conducted within the first two months of the growing season and periodic inspections will be made to assure continued health of the new plantings (see Section 8).

6.1.2.2 Aquatic and Wildlife Resources

The Muddy River in this area supports a warm water fishery, which likely includes bottom-feeding species, pan fish, forage species and some predatory fish. Blue back herring may also migrate through this river section. The benthic community (bottom inhabiting organisms) is pollution tolerant. The wildlife resources include urban species that have adapted to high human interference and a less than natural habitat containing a limited diversity. The existing aquatic and wildlife resources in the Charlesgate Area are limited.

Benthic Resources
The resident benthic resources will be the most severely impacted aquatic community from the dredging. There will be a near total loss of these species, which are dominated by pollution tolerant organisms. Recruitment (re-establishment of the population) will take a number of years because the upstream benthic pool will also be reduced. However, in weighing the negative and positive aspects of this loss, the value of the bottom food chain versus the planktonic food chain needs to be considered. Bottom feeding fish such as goldfish, suckers, and carp do not contribute in a positive manner to fish populations nor water quality. Studies have shown that bottom feeding fish substantially contribute to the murkiness of the water, nutrient levels, and algae growth by agitating the sediments, re-solubilizing nutrients into the water, promoting the growth of less desirable blue-green algae upon which zooplankton cannot feed, and damaging spawning nests of other fish. This results in negative water quality impacts that also produces a negative impact on the zooplankton and the food chain for pan fish and game fish. A fishery resource that is based on plankton for food is often considered to be more desirable than a dominating bottom food source.

In fishery management, it is a common practice to reclaim water bodies of undesirable species including the bottom dwellers. Following fish reclamation, water clarity improves, nutrient concentrations are reduced, the growth of blue-green algae decreases, and an increase in the extent of spawning nests for pan fish and game fish increases. Under the present conditions in the Muddy River, the bottom dwelling fish resource is dominant, and is undesirable due to its adverse effect on water quality and magnification of contaminants in the food chain. However, the dredging will not result in sterilization of bottom resources. Some benthic organisms will be 'kicked aside" by the turbulence of the dredging and remain to grow and reproduce. There will also be a continual recruitment of worms and midges from other upstream areas, including the unaffected portion of the "Babbling Brook", undredged parts of Wards Pond, Spring Pond, and storm drains that are not affected by the dredging operation.

Fish Resources
During dredging there will be some mortality of fish. The fish loss may be proportionally higher in the bottom dwelling species such as carp and suckers than the open water species such as sunfish, bass, etc.. This impact is not considered adverse, however, because the water quality of the Muddy River would benefit from substantially fewer bottom dwelling species, which enhance the cycling of nutrient and contaminants to the water.

The removal of sediment from the Charlesgate Area will result in an enhanced aquatic habitat for fish resources. The removal of contaminated sediment will lead to improved, dissolved oxygen and less nutrient, contaminant cycling, and turbidity from the sediments to the water. The removal of hydrocarbon compounds (DDT and PCBs) will also reduce the content of contaminants in edible fish tissue, thereby reducing bio-accumulation through the food chain. It is also anticipated that within a free flowing and deeper water column, combined with daylighted sections of the river, anadromous fish migration will increase.

Wildlife Resources

The positive long-term effects will outweigh the temporary negative impact to wildlife resources in the Charlesgate Area. Minimal disturbance to avian species will likely occur during dredging and re-vegetation operations as the birds relocate to areas of less disturbance. The planting of larger areas of trees and shrubs may attract greater numbers and diversity of birds after the construction has been completed. In locations where dredging occurs during winter hibernation, amphibian and reptile species will not be able to relocate and will be lost.

An active rodent control program will be enacted (see Section 7.0 – Environmental Mitigation Plan) to control rodent displacement during the dredging.

6.1.2.3 Rare Species

The Charlesgate Area does not contain any Federal or State listed rare, threatened or endangered species.

6.1.2.4 Wetland Resources

The Charlesgate area contains a narrow band of *Phragmites* that is growing on a root mat on top of the rip-rap embankment. While there will be a temporary encroachment into the buffer zone, the upland vegetation community will be enhanced as the result of re-vegetating with more shrubs and trees than presently exists. The re-vegetation plans are contained in Appendix I - Preliminary Design.

6.1.2.5 Ecological Functions and Values

Although the enhancement of the ecological communities in the Charlesgate Area is not targeted as much as it is in such locations as the Back Bay Fens and The Riverway, re-vegetating with more shrubs and trees will result in a marginal improvement in the ecological functions and values. Given the high degree of human activity in this area, there is little to be gained by any further re-vegetation than is planned.

6.1.3 Cultural Environment

6.1.3.1 Historic Resources

Construction of the Bowker overpass destroyed many features from the Primary and Secondary Periods of Significance. However, grading, vegetation, trees, surrounding structures and spatial relationships within the Charlesgate area contribute to its historic character. The Charlesgate East Gatehouse and a small structure along the

Muddy River and adjacent to the end of Ipswich Street are the only character defining features from the Primary Period (Olmsted) and the remaining balustrade areas are the only features that are extant from the Secondary Period (Shurtleff). These historic features need to be protected during construction so the impact on the character of the parkland will be minimal. At this time, these structures appear to be sufficiently distant from the contractor's operations not to require fencing. Specific vegetation in danger of damage from the operations would be protected by chain link fence if needed. Protection fencing will remain in place until final completion of all proposed adjacent work and then the protected areas will be restored as required. Entrance and egress to these features will be signed to control, direct, and protect pedestrian and vehicular access.

The existing vegetation has no historical integrity for either the Primary or Secondary Periods of Significance. The existing vegetation and horticultural resources date from 1964 when the Bowker Overpass was constructed. When the planting occurred in 1964, it appears that the design utilized some plant materials species from the historic plant lists from the 1884 planting design by Olmsted and the 1885 design for the Back Bay Fens Northern Basin by W. L. Fisher for the Olmsted Firm. Planting as proposed on the Preliminary Design Plans L-1 through L-5 will utilize the Olmsted plant lists.

The path system under the Bowker Overpass has no historical integrity for either the Primary or Secondary Periods of Significance. The sidewalks at Beacon Street and Commonwealth Avenue have integrity for the Secondary Period and will be protected during construction. Both the sidewalks and path system will be impacted to provide access to the river and to the staging areas so use of the path systems will be restricted at different times during construction. Movement within and across the park will be signed to control, direct, and protect pedestrian access during construction.

The shoreline was modified during the construction of the Bowker Overpass. Not only its location, but the treatment of its edge, has no historic integrity for either the Primary or Secondary Periods of Significance. The shoreline will be impacted only marginally by the work of this project and will be restored as required and areas of stone slope paving will be repaired.

Any damage to vegetation, paving etc. will be replaced in kind by the work of this project and any compacted areas will be aerated.

6.1.3.2 Land Use

The presence of a staging area in the Charlesgate will result in a minor disturbance in the use of this portion of the parkland. However, there will not be an adverse short-term nor long-term impact to land use. There will be no change in land uses due to this project.

6.1.3.3 Recreation

Recreation in this area historically and currently has been passive. Treatment of this area under this project will retain the passive recreation focus, but activity in this area will be impacted during construction and until the area is restored as part of the work of this project. Entrance and egress to the area will be signed to control, direct, and protect pedestrian access during construction.

6.1.3.4 Pedestrian Access

The physical bounds of the Charlesgate Staging Area will require temporarily closing the U-shaped path that is located within the staging area, as indicated on Figure 6-3. Weekday pedestrian counts indicate that this path is not heavily used (less than 10 pedestrians during the peak hour of the day). Moreover, this path is not a critical sidewalk link. It is more of a recreational sidewalk to a series of concrete benches. Over the years, the aesthetics of this area beneath the Storrow Drive ramps have seriously degraded, deterring pedestrians from using the U-shaped paths between Charlesgate West and Charlesgate East. Because of low utilization and the fact that this U-shaped path is not a critical link between two heavily used sidewalks, a temporary closure is not a significant impact to pedestrian access through the area.

At the Charlesgate Staging Area, construction trucks and contractor vehicles will be entering and exiting via Commonwealth Avenue eastbound, traversing a well used sidewalk along Commonwealth Avenue. This will result in an interruption to pedestrians when trucks are entering or exiting the staging area. Weekday counts indicate that the observed evening peak hour demand on this sidewalk is 215 pedestrians per hour occurring at about 4:00 PM. Although the heavy periods of construction activity do not coincide with peak pedestrian activity in this area, safety precautions must be taken to ensure pedestrian safety while trucks and contractors are entering and exiting the staging area.

6.1.4 Traffic

The project will add traffic to both regional roadways providing access to the study area and to local roadways abutting the Muddy River. The majority of the traffic generated for Charlesgate can be attributable to hauling dried dredge material from the staging area. The magnitude of this traffic is primarily a function of the productivity of the dredging and handling processes (for the staging area traffic). Table 6-1 provides a trip generation estimate for these activities.

As Table 6-1 indicates, the hydraulic dredging alternative is estimated to generate 20 truck trips per day and 10 trips per day for contractor vehicles (smaller trucks and passenger vehicles) and material delivery. Assuming a 7-hour workday and steady work productivity over the day, this is a total of approximately 4 trips per hour or about every 15 minutes. Section 4 indicates the lower volume of 540 vph in the Commonwealth Avenue area and the addition of 4 vph would have insignificant affect at nearby intersections.

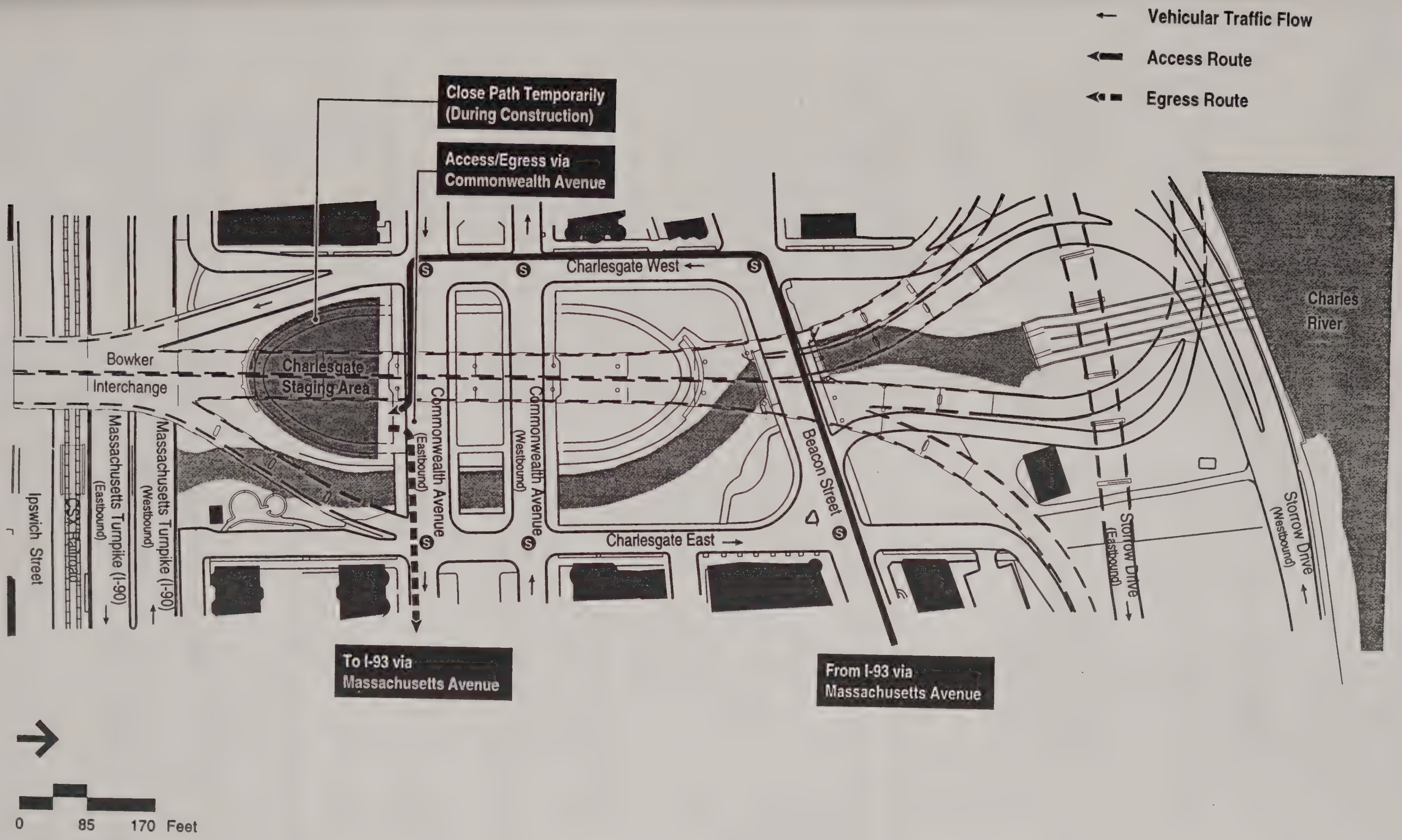

Vehicular Traffic Flow
Access Route
Egress Route
Close Path Temporarily (During Construction)
Access/Egress via Commonwealth Avenue
Charlesgate West
Charlesgate East
Charles River
Storrow Drive (Westbound)
Storrow Drive (Eastbound)
Beacon Street
Commonwealth Avenue (Westbound)
Commonwealth Avenue (Eastbound)
Charlesgate Staging Area
Bowker Interchange
Massachusetts Turnpike (I-90) (Westbound)
Massachusetts Turnpike (I-90) (Eastbound)
CSX Railroad
Ipswich Street
S
To I-93 via Massachusetts Avenue
From I-93 via Massachusetts Avenue
0
85
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Figure 6-3
Charlesgate Area Potential Staging Area Access/Egress Plan for Construction Traffic

Source: VHB, Inc.

Table 6-1
Trip Generation Estimate for Dredging Operations
Muddy River Restoration

	Estimated Trips per Day (vpd)[1]				Estimated Trips per Hour (vph)[2]
Staging Area Traffic - Hydraulic Dredging Alternative	Haul Trucks (40-cy capacity)	Haul Trucks (20-cy capacity)	Contractor Work Trips / Material Delivery	Total	Total
Enter	10	0	5	15	2
Exit	10	0	5	15	2
Total	20	0	10	30	4

1. vpd - vehicles per day.
2. vph - vehicles per hour. Estimated assuming an 7-hour workday for staging area traffic and a 10-hour night time work shift for culvert construction. Hourly trip rates are rounded.

With the proposed point of access/egress and the regional haul route to I-93, the traffic to/from the Charlesgate Staging Area will briefly follow a heavily traveled section of Commonwealth Avenue through intersections at Commonwealth Avenue and Charlesgate West/Charlesgate East that currently experience recurring peak hour congestion. The close spacing of these intersections, coupled with heavy traffic demands along Commonwealth Avenue and heavy left-turns from Commonwealth Avenue, cause the bulk of the traffic issues in this area. However, as indicated on Figure 6-3, the project traffic has been routed along Charlesgate West resulting in turning movements at lower volume approaches, thereby minimizing the project's impact. No traffic is added to the problematic left-turn movement from Commonwealth Avenue eastbound to Charlesgate East. Therefore, the proposed point of access/egress and regional haul route minimize the traffic impacts of the staging area activity.

6.2 Assessment of Environmental Impact in the Back Bay Fens

Construction activities that are proposed within the Back Bay Fens area include:

- The formation of three staging areas for sediment dewatering equipment and the loading of sediment into trucks,
- The improvement of the flood carrying capacity via the dredging and removal of approximately 95,450 cubic yards (cy) of accumulated sediment and debris,
- The preservation of the historic park shoreline through the removal of approximately 23,494 cy of *Phragmites* and the restoration of the bank to its historic intent,

- Daylighting of presently culverted sections at The Fens Bridge and the former Sears parking lot,
- Replacing culverts at The Riverway and Brookline Avenue adjacent to the former Sears parking lot and repairing the Fens Bridge culvert and headwalls,
- The preservation of the historic park features by the re-vegetation of the new bank, and the establishment of wetland areas the restoration of terrestrial habitat with indigenous plantings,
- Re-vegetation of the staging areas upon completion of the work,
- The repair or replacement of worn pathways and denuded ground,
- Installation of new park benches and waste barrels.

The proposed construction and re-vegetation activities are discussed in Section 5.0 - A Description of the Project's Design and Construction, including details, are shown in the Preliminary Design Report provided in Appendix I.

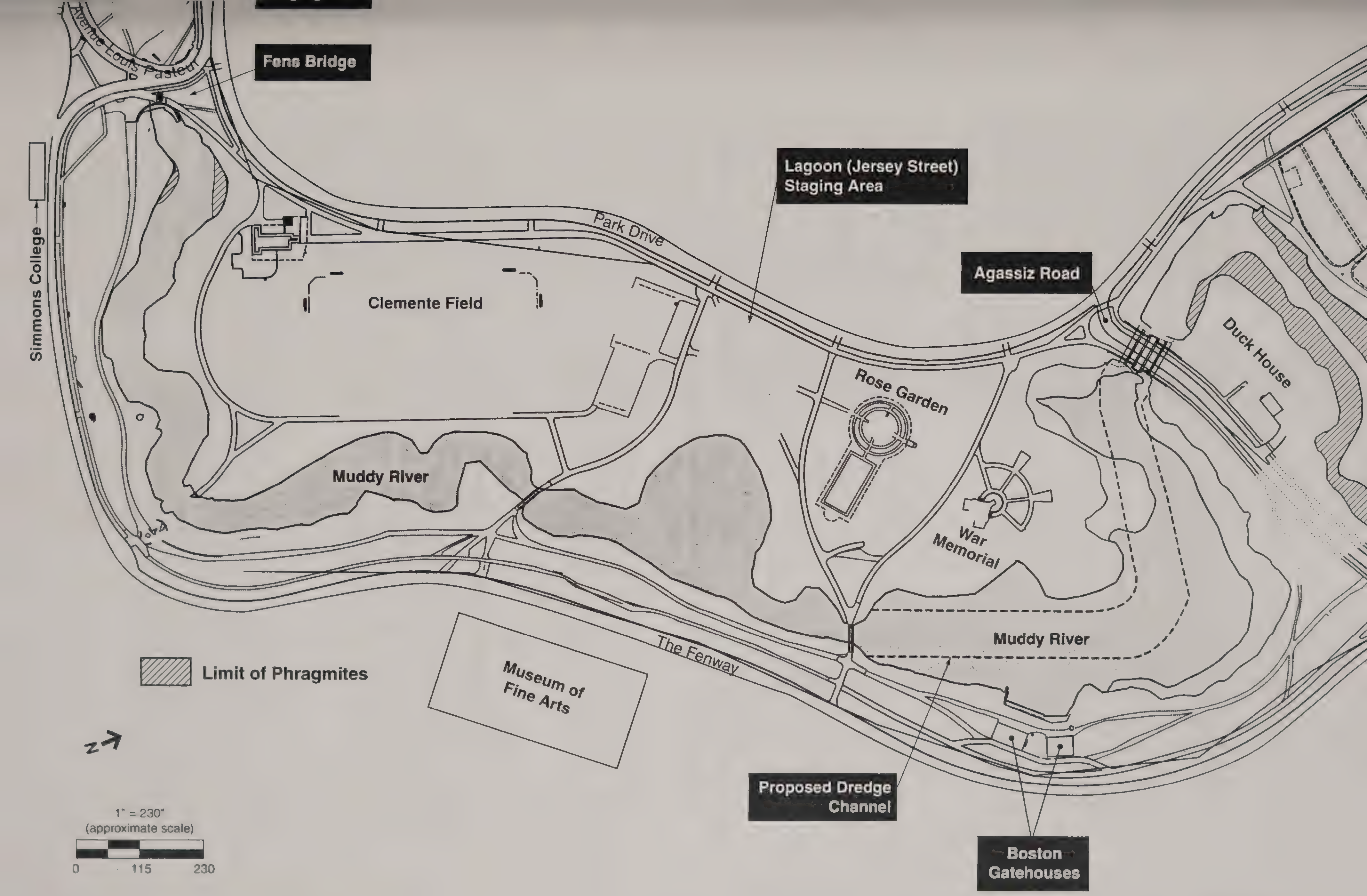
The types of impacts that have been analyzed include those to the physical (hydrology, sediment, staging areas, etc), chemical (water quality), biological (benthic macroinvertabrates, insects, fish, birds, vegetation, etc.) and human (pedestrian movement, traffic, staging areas, park use, etc.) environmental elements

6.2.1 Physical Environmental Features

A consistent goal of the Muddy River Project is to provide as much ecosystem enhancement as possible. In the Back Bay Fens, the proposed work includes:

- A substantial habitat upgrade through the removal of monotypic stands of *Phragmites*,
- the stabilization of eroding or undercut banks,
- The planting of diverse species of wetland vegetation,
- The establishment of Best Management Practices (BMP's) to improve water quality,
- The establishment of diverse masses of upland Olmsted shrubs and trees in the restored park configuration.

The physical environmental features in the Back Bay Fens will be disturbed temporarily during construction. There will be long-term physical alterations at The Fens Bridge and former Sears parking lot, where culverted sections are proposed to be daylighted and restored to more natural ecosystems. As shown in Figure 6-4, three staging areas will be required for the proposed project to be implemented in an



CDM Camp Dresser & McKee Inc.

Figure 6-4
Lower Fens Southern Basin & Lagoon (Jersey Street) Staging Area

orderly, effective and environmentally sound manner. The Agassiz Road, Lagoon, and Fens Bridge staging areas will be used for dredging-related activities. The Fens Bridge staging area also will be used for construction activities that are associated with the proposed daylighting of the culverted section of the Muddy River in this area. Approximately 31,000 square feet (sf) along Agassiz Road, approximately 52,000 sf at the Lagoon, and approximately 43,000 sf at The Fens Bridge will be utilized for staging. In addition, there will be construction activities in the former Sears parking lot, that are related to the construction of an arch culvert under The Riverway roadway as well as the proposed daylighting of the former parking lot area. The staging areas may be utilized from 14 to 17 months, depending on the time of year they are closed and re-vegetated.

6.2.1.1 Hydrology

As discussed in Section 4.3.1.1, there are physical obstructions to the flow of water in the Back Bay Fens area. These include the extensive growth of *Phragmites* into the River, and significant sediment and debris accumulation. The goal of dredging the Muddy River through the Back Bay Fens area is to improve the hydraulic capacity and enhance the natural and cultural environmental features of the area. The project has been designed to prevent an interruption of water flow in the Muddy River during construction. In the event of a storm where dredging equipment could interfere with flow, the Contractor will be required to remove equipment during such storms, and where necessary, provide sufficient pumping equipment so as not to exacerbate upstream flooding.

The model indicates that the proposed improvements throughout the Muddy River will result in a significant decrease in maximum water levels throughout the reach for the October 1996 storm. Figure 6-5 shows the maximum water levels for the storm for both the existing conditions and the improved conditions.

For the October 1996 storm, the water level in this reach was reduced in the downstream area by the Ipswich Street Bridge, and more dramatically in the upstream end near the Brookline Avenue Gatehouse and The Riverway crossing. The Ipswich Street area benefits from about a 1.1 ft reduction in water elevation from 11.6 to 10.5 ft BCB. The water level at The Riverway (road) near the Sears parking lot is reduced almost 5.3 ft from elevation 18.9 ft to 13.6 ft BCB. Accordingly, the Muddy River Project will result in a positive environmental impact by increasing the hydraulic capacity of the River.

6.2.1.2 Sediment Quality

To date about 94,500 cubic yards of sediment (not including Phragmites), which will be removed by dredging, has accumulated in the Back Bay Fens area. It consists of organic silt and fine to coarse sand and gravel with some bricks, wood, concrete, glass, etc. Organic matter, consisting of decayed plant matter, sticks, root mass, and peat, was observed in the upper limits. The native underlying material consists of gray silt and sand and some gravel (i.e. the remains of an estuary). The sediments

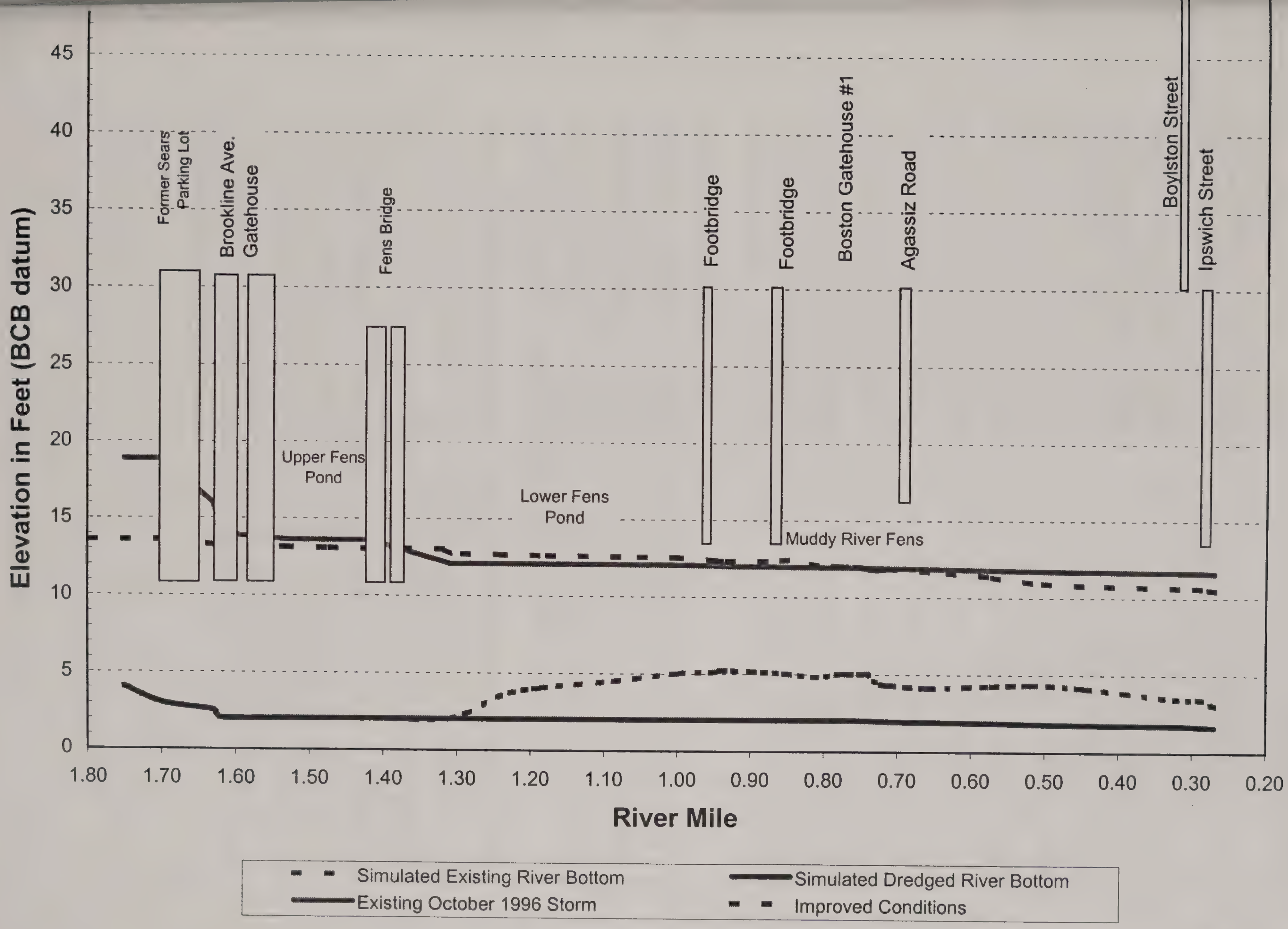


Figure 6-5
Peak Hydraulic Grade Line - October 1996 Storm
Existing and Improved Conditions - Back Bay Fens

have been found to contain PAHs, PCB, arsenic and lead (see Appendix F - Sediment Characterization). Sediment results for the Back Bay Fens show elevated concentrations of analytes primarily in the top sediment layer. Based on the five foot average dredging depth proposed (see Figure 6-6), most of the contaminated material will be removed. Several samples in the Lower Fens Southern and Northern Basin did contain concentrations of TCLP lead and reactive sulfides above the regulatory limit as well as elevated concentrations of arsenic and conductivity that may not be removed. The results for conductivity, however, are consistent with the original land use of the Back Bay Fens that was a salt marsh. The results suggest that urban runoff could be a continuing source of contamination. The BWSC is conducting programs to significantly improve the water quality in the Stony Brook conduit and reduce loading associated with the events when the conduit overflows in the Back Bay Fens. As the result of the BWSC's Stony Brook Conduit Illegal Connection Investigation Project and the Stony Brook Conduit Improvement Project, illegal sanitary sewer connections are being eliminated and accumulated sediment has been removed and control structures are being repaired. This will substantially increase the stormwater conveyance capacity of the Conduit, without the presence of sewage and, therefore, should contribute less sediment and contamination to the Lower Fens Southern and Northern basins.

6.2.1.3 Water Quality

Stormwater comprises the majority of water flowing through the Back Bay Fens area. Therefore, the present water quality of the Muddy River at this location is affected by the quality of upstream reaches. Water in the Back Bay Fens area is warm and has been found to have exceedances of the water quality criteria for fecal coliform bacteria and dissolved oxygen. The water is also enriched with nutrients, which accelerates algae and aquatic plant growth. See Appendix G for water quality.

Long-term and short-term impacts to water quality will occur during the life of the Muddy River Project. The short-term negative impacts to water quality will be mitigated to a large extent by construction mitigation measures that are described in Section 7.0 Although much is written in this section about the short-term negative impacts to water quality from construction activities, one cannot loose sight of the significant and beneficial long-term impacts that will be derived from the Project. The removal of contaminated sediment will reduce sediment oxygen demand and will improve dissolve oxygen and decrease nutrient and contaminant cycling from the sediments to the water. In order to enhance the water quality of the Muddy River, a Best Management Practices (BMP) program (see Section 5.9- Best Management Practices), and a water quality monitoring program (see Section 7.0- Environmental Mitigation Plan) will be implemented.

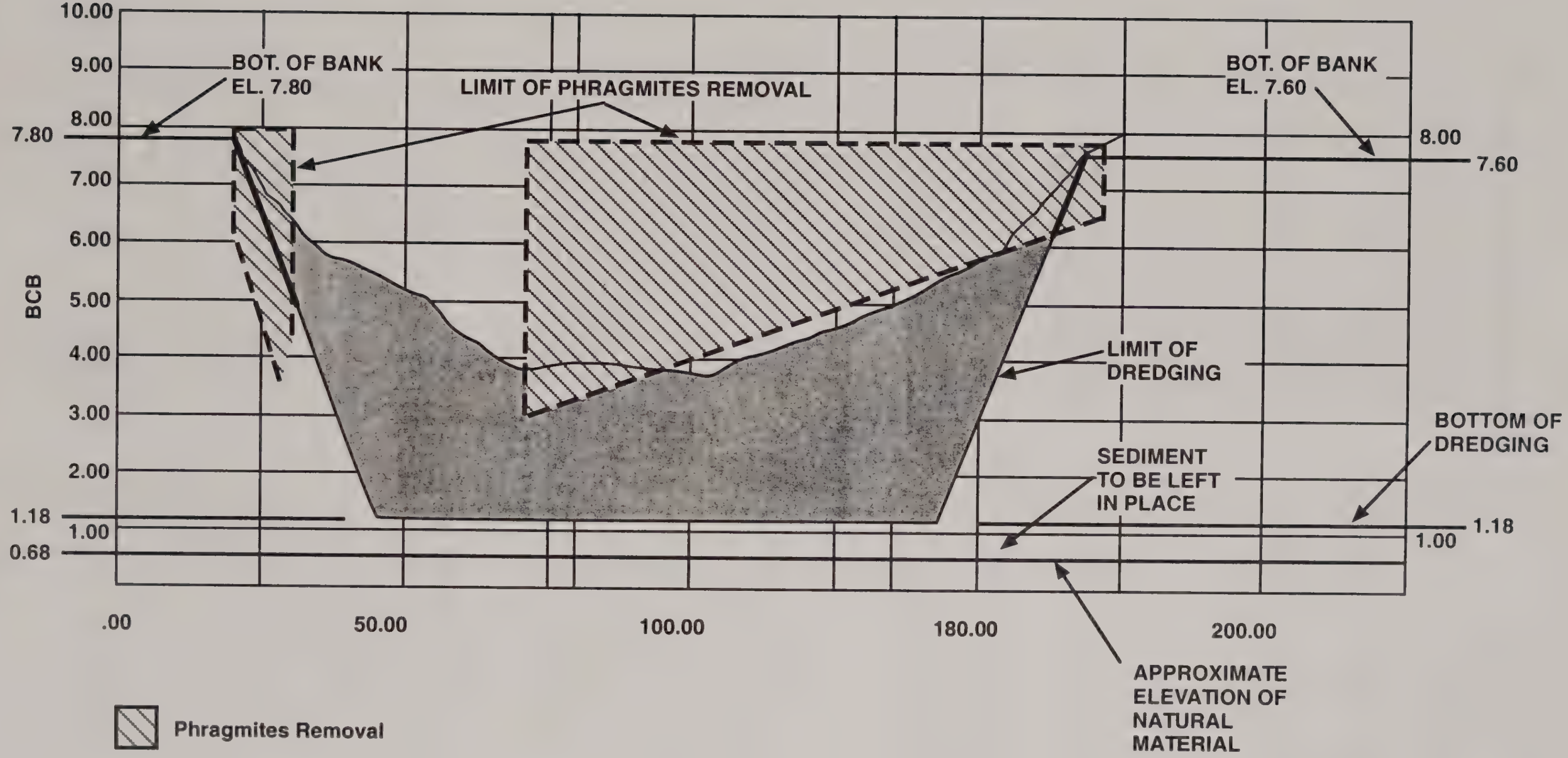


Figure 6-6
Typical Cross Section in Back Bay Fens

The long-term impacts to water quality will be beneficial in that:

- The removal of the sediment will increase the flood flow capacity of the River,
- The removal of the contaminated sediment will enhance the quality of the River bottom for colonization by benthic organisms,
- The volume of the aquatic habitat will be substantially increased,
- The spawning habitat for fish will be improved,
- There may be an increase in the migration of anadromous fish, and
- The overall quality of the aquatic/riparian/upland habitat and its diversity will also be substantially improved.

During construction there will be at least three temporary sources of water to the Muddy River. These sources include 1) staging area runoff, 2) turbid water from the removal of the *Phragmites* root mat, dredging and debris removal, 3) return waters from the dredging and the belt filter presses processes, and 4) turbidity from sheet pile extraction.

Staging Area Runoff
In order to provide a workable surface, it is expected that the Contractor will form the staging area by placing a layer of crushed stone over the existing ground. In this manner the compaction and erosion of the underlying soil will be minimized. Runoff will be controlled and the Contractor will be required to submit a Stormwater/Dewatering Pollution Prevention Plan (S/DPPP) for approval by the Project, the DEP and the Boston Conservation Commission before construction is allowed to proceed. The S/DPPP will contain an Erosion and Sedimentation Control Plan and a Spill Prevention Control and Countermeasure Plan for each staging area (see Section 7.0 - Mitigation Measures).

Turbid Water from the Removal of Root Mats, Dredging, and Debris Removal
There will be a certain amount of unavoidable turbidity that is generated from the removal of the *Phragmites* root mats, at the dredge site and locations where excavators must remove debris. This impact will be limited in duration, and due to the extremely low flow volume of the Muddy River, the lateral extent of this impact will be limited. Wherever possible, the dredging areas will be separated from that portion of the Muddy River where water is flowing by silt curtains in orders to contain any turbidity. The monitoring of turbidity is Hardy Pond during hydraulic dredging operations indicated that there was minimal release of turbidity form the cutter head. In order to provide a limitation on the level of suspended solids in the Muddy River that originate from the dredging itself, it is proposed that the in-stream suspended solids not exceed 200% of background concentrations at a distance of 200 feet from the dredge.

The removal of the stalks and root mats of *Phragmites that is growing both in the Charlesgate area between Ipswich Street and the Richardson Bridge (see Section 6.1.1.3) as well as in the Back Bay Fens* will be conducted in two steps. First the stalks will be cut, mulched and trucked from the site for composting. When possible, stalks should be cut before flowering to prevent spread of seeds and the latest horticultural practices followed to prevent future reinfestation. The second step will involve the removal of the root mat from the water by an excavator on a barge. The excavator will place the root mat on a deck barge that when full will be moved to the unloading area at Agassiz Road. From this point the root mats will be removed to either a composting or disposal facility, as post-excavation testing indicates. Turbidity will be generated during excavation on the root mat. Minimization and control of the turbid water will be conducted by deploying silt curtains that extend the full depth of the water column along the perimeter of the root mat. The excavator bucket will be perforated to allow excess water to drain from the bucket prior to placing the material on the deck barge. After allowing the excess water to drain into the silt curtained-off excavation area, the excavator will then place the materials on the deck barge. The barge will have steel sides that do not leak water into the River. At Agassiz Road unloading area, the barge will be docked, a silt curtain will be placed around the barge and another excavator will remove the materials from the barge and place them into specially constructed roll-off containers that will allow excess water to drain from the materials. The excess water will drain into a sump from which it will be pumped into the fractionation tanks at the head end of the dewatering treatment process. In this manner, the turbid water will be contained along all steps of the excavation and handling process. The contact of turbid water from within the silt curtained-off excavation area and water flowing down the Muddy River will be minimized to the best extent possible.

Return Water from the Dredging and the Belt Filter Presses.
The most efficient procedure to remove and treat the sediment for landfill management will be through the use of hydraulic dredging methods. The hydraulic dredging method includes a dredge that floats on pontoons and pumps that take in water through a rotating auger that cuts into the sediment. This results in the entrainment of the sediment with water. Conventional hydraulic dredging involves the mixing of one part of sediment with four parts of water. The water, therefore, serves as the transport medium for the sediment.

From the dredge, the sediment slurry will be pumped to the staging area where it will be treated with a polymer and filtered through a belt filter press. The polymer enhances the separation of water from sediment and the result will be a high solids content filter "cake" that will be loaded into a truck by a conveyor. The low moisture filter cake will be removed from the site and transported to a suitable management/disposal facility. Based on the experience from dredging Hardy Pond in Waltham, MA, the maximum daily production of 400 cy of filter cake from one hydraulic dredge and a belt filter press assembly could result in the generation of approximately 200 gallons per minute of return water. While a hydraulic dredge is capable of dredging far greater quantities of sediment, the limiting factor is the processing rate of the belt filters. The return water will be filtered through a fine mesh mechanical filter prior to discharge to the Muddy River.

The return water will probably contain a total suspended solids (TSS) concentration of 50 milligrams per liter (mg/l) and a maximum daily limit of 100 mg/l. In order for the Contractor to receive approval to proceed with the work, a DMMP will be prepared and submitted for approval by both the DEP and the BCC. Water quality monitoring of the return water as well as that in the Muddy River will also be implemented. Further details on the outline of the DMMP are contained in Section 7.0 - Environmental Mitigation Plan.

Turbidity from Sheet Pile Extraction
During the day lighting, steel sheet piles will be driven using vibratory hammers on cranes for earth support during the construction of the culverts and headwalls. While not all sheeting will later come in contact with the Muddy River water, the soil at some sheeting will be excavated as the construction is completed and water will be allowed into the area. The sheeting will then be removed by either cutting it at the water line, or extracting it by using vibratory equipment on a crane. As the sheeting is extracted, the soil that has adhered to the sheeting will be slough off and fall into the water. Because silt fencing will already have been placed along the edge of the construction, the turbidity from this sloughing will be contained.

Best Management Practices
BMP that are proposed include; the installation of a particle separator on the Emmanuel College drain (subject to the outcome of the pilot study), the construction of wetland water quality swales between the Victory Gardens and the Muddy River, monitoring the quality of drainage water from the Victory Gardens, and the repair of erosion from desire lines and other sources of sediment. In addition, the BWSC is implementing the city-wide Boston Catch Basin Maintenance Program and the Stony Brook Conduit Project that will also have a positive impact on the water quality in the Back Bay Fens.

Proceeding on an independent schedule from the Muddy River Restoration Project is the separation of surface runoff from the Back Bay Yard into the local sanitary sewer. This Notice of Project Change (NPC) was noticed in the Environmental Monitor on August 22, 2001. It included the construction of 300 linear feet of storm drain, 2 deep sump hooded catch basins, a deep sump manhole with a deeper hood, an infiltration chamber and an overflow from the chamber for high storm flows. The MEPA Certificate on the Notice of Project Change indicated that no further MEPA review was necessary. The BPRD has submitted the plans in a Notice of Intent (NOI) to the Boston Conservation Commission and has received its Order of Conditions. See Appendix L for NPC, NOI and Order of Conditions.

6.2.2 Biological Environment

The proposed Muddy River Project will result in the ultimate enhancement of the biological environment. This work includes enhancing the upland vegetation, wetlands, and aquatic and wildlife resources. However, in the course of conducting the dredging, construction and restoration work, temporary disturbances to the biological resources will result. Short-term and long-term impacts to the biological resources are included in the following sections.

6.2.2.1 Upland Vegetation and Horticultural Resources

The Agassiz Road staging area presently contains the roadway itself, good grass ground cover, mature and younger trees, few shrubs, dense *Phragmites* along the shoreline, and paved and unpaved walkways. The lagoon staging area is well grasses with young trees, stands of mature Lilac bushes, and paved pathways. The Fens Bridge staging area is also grassed, contains scattered shrubs, patches of young trees, and is bordered by mature Olmsted Trees, and is traversed by paths. In 1989, the use of former Sears parking lot was discontinued, seeded with grass, young trees were planted and substantial pedestrian traffic has worn pathways into this area. The Muddy River currently passes under the site through two six- foot diameter culverts.

Existing vegetation adjacent to the river and in the staging areas will be impacted and some vegetation will be removed to accomplish the work of this project. However, every effort has been made to minimize any loss of mature trees unless they are already of poor quality and health. Trees adjacent to the contractor's operations will be protected with chain link fence as needed. The staging areas at Agassiz Road and the Lagoon are anticipated to be approximately 31,000 sf and 52,000 sf in size. The Fens Bridge staging areas may be approximately 43,000 sf. These sites may be utilized for approximately 14-17 months, depending on the time of year they are closed and can be re-vegetated. The staging areas and shoreline areas where the bank is to be regarded and revegetated are shown in the Preliminary Design Report in Appendix I. The project plans call for removal of invasive vegetation including *Phragmites*, Japanese knotweed and glossy buckthorn.

The bank restoration and re-vegetation process will be staged such that the extent of bare ground will be minimized at any point in time. Silt fencing will be placed and maintained along all areas to be disturbed. As soon as bank re-grading work in an area is completed, the soil in the area will be tilled and aerated and will either be sodded or mulched with pine bark in advance of the planting of vegetation. Sod will be pegged into the ground on slopes greater than 3:1. The wetland shelf will also be planted as soon after re-grading as possible.

When a staging area is to be restored, the crushed stone base will be removed and the loam ground restored, tilled and aerated. The surrounding silt fencing, however, will remain until grass is growing. Only then will it be removed and the growing where the fence had been will be raked level and seeded. Seeding will be conducted by hydromulching. In the event that a staging area is to be closed outside of the growing season, the site security and siltation fencing will remain in place until the next growing season. Complete site restoration will be conducted within the first two months of the growing season.

6.2.2.2 Aquatic and Wildlife Resources

The existing aquatic and wildlife resources in the Back Bay Fens area are limited by the lack of diversity of plants and habitat structure. The Muddy River in this area supports a warm water fishery, which includes bottom feeding species, pan fish, forage species and some predatory fish such as bass. Blue back herring may migrate through this river section. The benthic resources (bottom inhabiting organisms) are pollution tolerant. The wildlife resources include urban species that have adapted to high levels of human interference and a less than natural habitat with limited diversity. See Section A for existing resources.

Benthic Resources

The benthic resources will be the most severely impacted aquatic community from the dredging. There will be a near total loss of these species, which are dominated by pollution tolerant organisms. Recruitment (population re-establishment) will take a number of years because the upstream benthic pool also will be reduced. However, in weighing the negative and positive aspects of this loss, the value of the bottom food chain versus the planktonic food chain needs to be considered. Bottom feeding fish such as goldfish, suckers, and carp do not contribute in a positive manner to fish populations nor water quality. Bottom feeding fish substantially contribute to the murkiness of the water, nutrient levels, and algae growth by agitating the sediments, re-solubilizing nutrients into the water, promoting the growth of less desirable blue-green algae upon which zooplankton cannot feed, and damaging spawning nests of other fish. This results in negative water quality impacts that also produces a negative impact on the zooplankton and the food chain for pan fish and game fish. A fishery resource that is based on plankton for food often is considered to be more desirable than a dominating bottom food source.

In fishery management, it is a common practice to reclaim water bodies of undesirable species including the bottom dwellers. Following fish reclamation, water clarity improves, nutrient concentrations are reduced, the growth of blue-green algae decreases, and an increase in the extent of spawning nests for pan fish and game fish increases. Under the present conditions in the Muddy River, the bottom dwelling fish resource is dominant, and is undesirable due to its adverse effect on water quality and magnification of contaminants in the food chain. However, dredging will not result in a sterilization of bottom resources. Some benthic organisms will be 'kicked aside" by the turbulence of the dredging and remain to grow and reproduce. There also will be a continual recruitment of worms and midges from other upstream areas, including the unaffected portion of the "Babbling Brook", undredged parts of Wards Pond, Spring Pond, and storm drains not affected by the dredging operation.

Fish Resources

During dredging there will be some loss of fish. The mortality may be proportionally higher in the bottom dwelling species than the open water species. This impact is not considered adverse, however, because the water quality of the Muddy River would benefit from substantially fewer bottom dwelling species.

The removal of sediment from the Back Bay Fens will result in an enhanced aquatic habitat for fish resources. The removal of contaminated sediment will result in improved dissolved oxygen and less nutrient and contaminant cycling from the sediments to the water. The removal of hydrocarbon compounds (DDT and PCBs) also will reduce the content of contaminants in edible fish tissue, thereby reducing bio-accumulation through the food chain. It is also anticipated that within a free flowing and deeper water column combined with daylighted sections of the river, anadromous fish migration will increase.

The removal of organic sediments, which are not conducive for spawning of the common pan and game fish species, will result in the exposure of granular sediments on which these fish can spawn.

Wildlife Resources

The positive long-term effects will outweigh the temporary negative impact to wildlife resources in the Back Bay Fens. Minimal disturbance to avian species likely will occur during dredging and re-vegetation operations as the birds relocate to areas of less disturbance. The planting of larger areas of trees and shrubs may, however, attract greater numbers and diversity of birds after the construction has been completed. In locations where dredging occurs during winter hibernation, amphibian and reptile species will not be able to relocate from the dredging and will be lost. Despite this, sufficient sediment will remain to accommodate some displaced amphibians and reptiles.

An active rodent control program will be enacted (see Section 7.0 – Environmental Mitigation Plan) to control as much rodent displacement as possible during the dredging. In order that the goose problem that exists at Leverett Pond does not become relocated to the Back Bay Fens, there will be a multi-faceted program for goose control. This is described in Section 8 - Management and Maintenance.

The re-vegetation of the Back Bay Fens will result in a substantial increase of habitat bio-diversity as the result of an improved composition of the aquatic, wetland, shrub and tree canopy components of the ecosystem. The proposed planting plan and extent of planning is shown in detail in the Preliminary Design Report contained in Appendix I. (Figure L-1 to L-50). Figures 6-7 and 6-8, taken from the Preliminary Design Report, are illustrations of the typical plant massing that are proposed for the Back Bay Fens in the Victory Garden area. A selection of typical cross-sections of

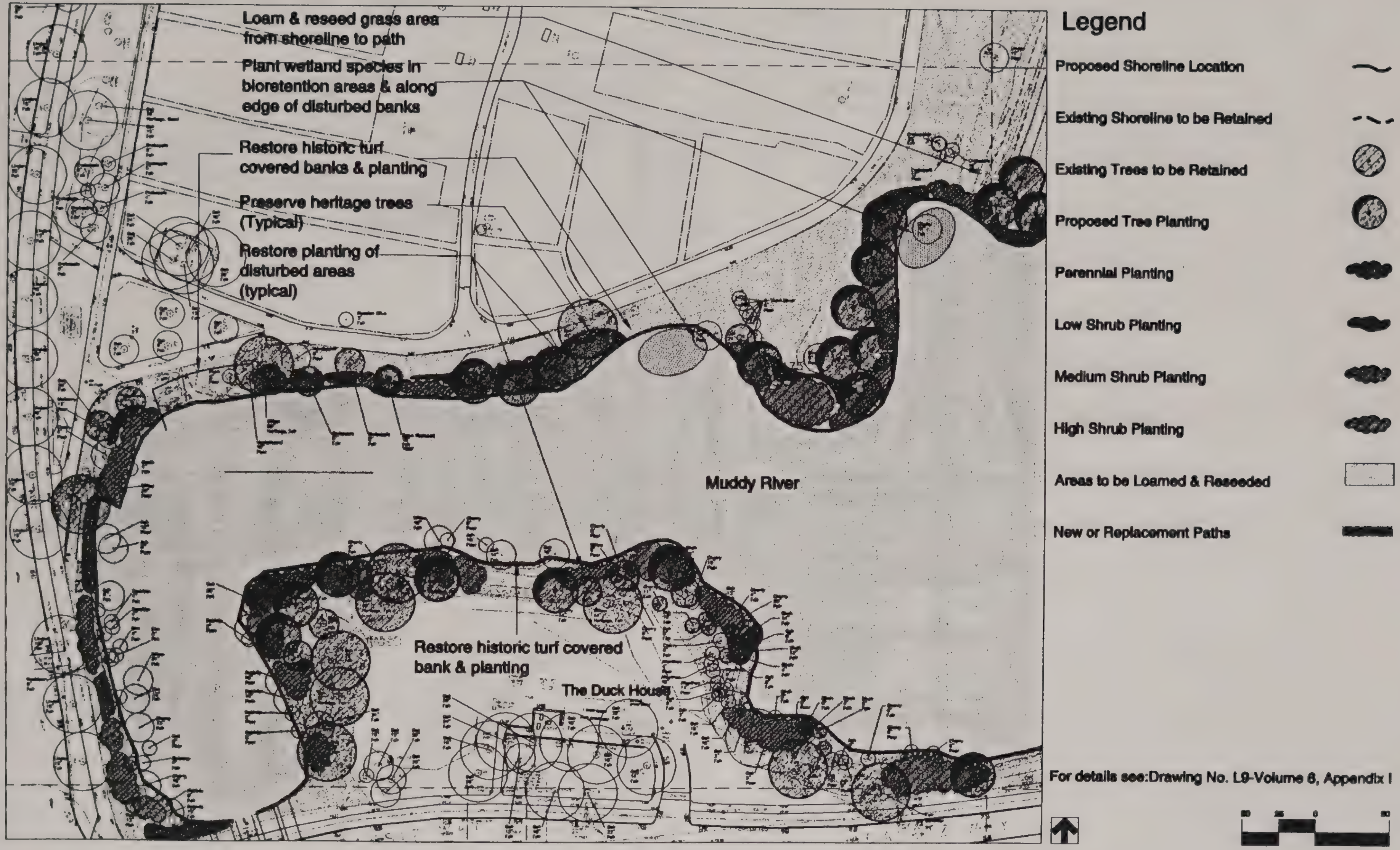

Loam & reseed grass area from shoreline to path
Plant wetland species in bioretention areas & along edge of disturbed banks
Restore historic turf covered banks & planting
Preserve heritage trees (Typical)
Restore planting of disturbed areas (typical)
Muddy River
Restore historic turf covered bank & planting
The Duck House
Legend
Proposed Shoreline Location
Existing Shoreline to be Retained
Existing Trees to be Retained
Proposed Tree Planting
Perennial Planting
Low Shrub Planting
Medium Shrub Planting
High Shrub Planting
Areas to be Loamed & Reseeded
New or Replacement Paths
For details see:Drawing No. L9-Volume 6, Appendix I

Figure 6-7
Typical Plant Massing Proposed for the Back Bay Fens, near the Victory Gardens
Source: Pressley, Inc.

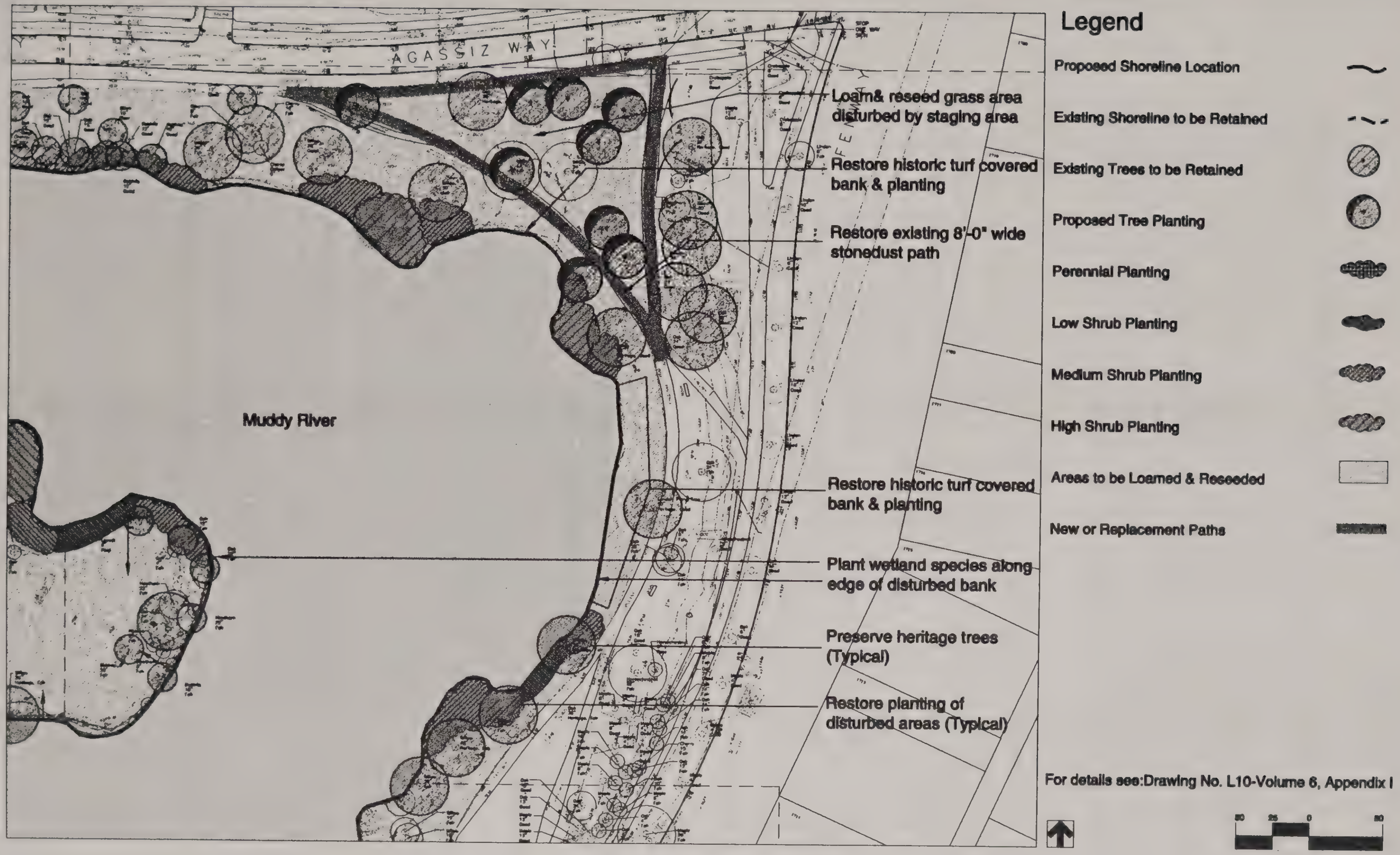

AGASSIZ WAY
FENWAY
Muddy River
Loam& reseed grass area disturbed by staging area
Restore historic turf covered bank & planting
Restore existing 8'-0" wide stonedust path
Restore historic turf covered bank & planting
Plant wetland species along edge of disturbed bank
Preserve heritage trees (Typical)
Restore planting of disturbed areas (Typical)
Legend
Proposed Shoreline Location
Existing Shoreline to be Retained
Existing Trees to be Retained
Proposed Tree Planting
Perennial Planting
Low Shrub Planting
Medium Shrub Planting
High Shrub Planting
Areas to be Loamed & Reseeded
New or Replacement Paths
For details see:Drawing No. L10-Volume 6, Appendix I
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Figure 6-8
Typical Plant Massing Proposed for the Back Bay Fens
Source: Pressley, Inc

Muddy River in Back Bay that show re-vegetation limit is contained in Figures 6-9(a and b) and the typical bank cross sections are shown on Figure 5-11 and 5-12.

Because the Muddy River was a tidal estuary when Olmsted prepared his design, it was necessary to select freshwater wetland plants that would grow in today's freshwater environment. The list (Table 6-2) includes 20 species of shrubs and trees from the original Olmsted planting list, six species of shoreline plants, and eleven species of emergent wetland plants. There is no plan to introduce submersed aquatic species because they will colonize the aquatic environment as seeds are introduced by waterfowl and upstream sources.

The habitat in those areas where *Phragmites* removal is proposed will be restored with an indigenous plant community. The primary goal of this restoration process is to create a healthy ecosystem containing a variety of plant communities (i.e., diversity) ultimately resulting in the development of significant and valuable structural heterogeneity. This diverse habitat is preferred by a wide-variety of avian, mammalian and invertebrate species. Wading birds such as great blue heron, green heron and black-crowned night heron will take advantage of bank habitat. The interface or edge effect between terrestrial and aquatic environments (the ecotone) provides significant food sources, shelter, breeding and nesting areas for a variety of invertebrates, including dragonflies, butterflies and beetles, which in turn provide food sources for all growth levels (larval, pupa and adult) for avian and small mammal species.

Table 6-2

PROPOSED WETLAND, SHRUB AND CANOPY PLANTINGS FOR HABITAT AND HISTORIC VALUE

Species Position	Indicator Status,Landscape
Olmsted Shrubs and Trees	
■ Red maple *(Acer rubrum)*	FAC, Canopy
■ Speckled alder (*Alnus rugosa)*	FACW+,Shrub
■ Smooth alder *(Alnus serulata)*	OBL, Shrub
■ Red chokeberry *(Aronia arbutafolia)*	FACW, Shrub
■ Lady Fern *(Athyrium felix-fermia)*	FAC, Groundcover
■ Gray birch *(Betula populifolia)*	FAC, Canopy
■ Buttonbush *(Cephalanthus occidentalis)*	OBL, Shrub
■ Sweet pepperbush *(Clethra alnifolia)*	FAC+, Shrub
■ Silky dogwood *(Cornus amomum)*	FACW, Shrub

(continued)

Table 6-2 (continued)

PROPOSED WETLAND, SHRUB AND CANOPY PLANTINGS FOR HABITAT AND HISTORIC VALUE

Red-osier dogwood *(Cornus stolonifera)*	FACW+
Witch-hazel *(Hamamelis virginiana)*	FAC-
Winterberry *(Ilex verticillata)*	FACW+, Shrub
Spicebush *(Lindera benzoin)*	FACW-, Shrub
Cinnamon fern *(Osmunda cinnamomea)*	FACW, Groundco
Swamp azalea *(Rhododendron viscosum)*	OBL, Shrub
Common elderberry *(Sambucus canadensis)*	FACW-, Shrub
Withe-rod *(Viburnum cassinoides)*	FACW, Shrub
Arrowwood *(Viburnum dentatum)*	FAC, Shrub
Nannyberry *(Viburnum lentago)*	FAC, Shrub
Tupelo *(Nyssa sylvatica)*	FACW+, Canopy

Shoreline Plants

Blue Joint Grass *(Calamagrostis canadensis)*	FACW,
Jack-in-the-pulpit *(Arisaema triphyllum)*	FACW,
Turk's Cap Lily *(Lilium superbun)*	FACW,
St John's Wort *(Hypericum virginicum) (Hypericum canadense)*	FACW,
Forget-me -nots *(Myosotis scorpioides)*	FACW,
Cardinal flower *(Lobelia cardinalis)*	FACW,

Emergent Wetland Plants

Broadleaf arrowhead *(Sagittaria latifolia)*	OBL,
Pickerelweed *(Pontederia cordata)*	OBL,
Blue flag *(Iris versicolor)*	OBL,
American burreed *(Sparganium americanum)*	OBL,
Soft-stemmed bulrush *(Scirpus validus)*	OBL,
Three Square bullrush *(Scirpus pungens)*	OBL,
Sweet flag *(Acornus calamus)*	OBL,
Water smartweed *(Polygonum amphibium)*	OBL,
Arrow arum *(Peltandra virginica)*	OBL,
Water plantain *(Alisma plantago-aquatica)*	OBL,
Marsh-mallow *(Hibiscus moscheutos formerly Hibiscus palustris)*	OBL,

(continued)

Table 6-2 (continued)

PROPOSED WETLAND, SHRUB AND CANOPY PLANTINGS FOR HABITAT AND HISTORIC VALUE

KEY

Habitat Conditions:

FACW	Facultative Wetland - plants that occur in wetlands (67-99%) of the time, but are occasionally found in upland areas.
FAC	Facultative - plants that occur in wetlands (34-66%) of the time, although they are equally likely to occur in upland areas.
FACU	Plants that usually occur in uplands and are seldom found in wetlands.
OBL	Obligate - plants that grow in saturated or inundated conditions (>99%) of the time during the growing season.
NI	Not indicated.

+ or – categories: '+ ' indicates a frequency to grow in wetter conditions, and '-' indicates a frequency to grow in dryer conditions.

Landscape Position:
Groundcover: not to exceed 3-feet in height.
Shrub: 3-20 feet in height.
Canopy: Greater than 15-feet in height.

6.2.2.3 Rare Species

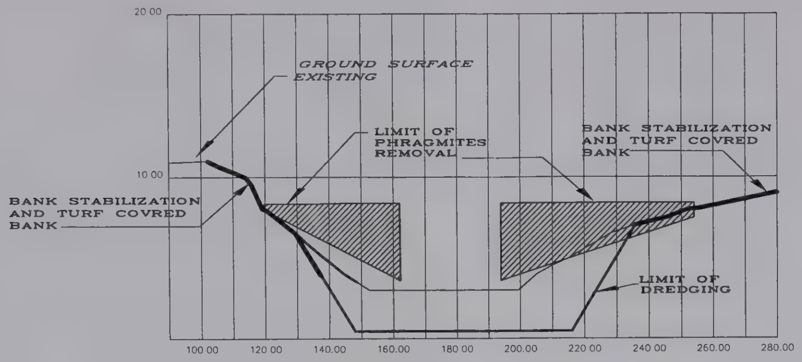
The Back Bay Fens area does not contain any rare, threatened or endangered species.

6.2.2.4 Wetland Resources

The Back Bay Fens area contains extensive monotypic stands of *Phragmites*. The *Phragmites* has expanded significantly and established extensive mats into the watercourse resulting in the restriction of the flood carrying capacity of the Muddy River. The *Phragmites* has also grown up the bank and encompasses much of the bordering vegetated wetland resources.

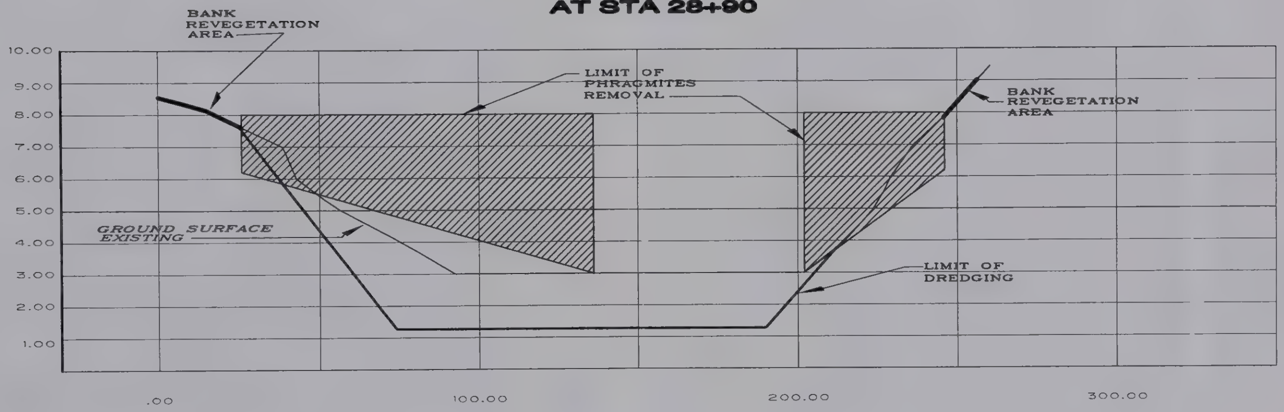
The proposed work includes the total removal of the *Phragmites*, including the extensive root system, and the introduction of plant species that are listed in Table 6-2. Where one species dominates the present ecosystem, it will be replaced by six species of shoreline plants and eleven species of emergent plants. This will result in a substantial enhancement of the functions and values of the aquatic, wetlands, and upland ecosystems as well as a commensurate enhancement in wildlife functions and values.

Table 6-3 contains a comparison of the present and future extent of the wetland resource areas. In accordance with the Wetland Protection Act, most of the bank and



CROSS SECTION 6A

AT STA 28+90



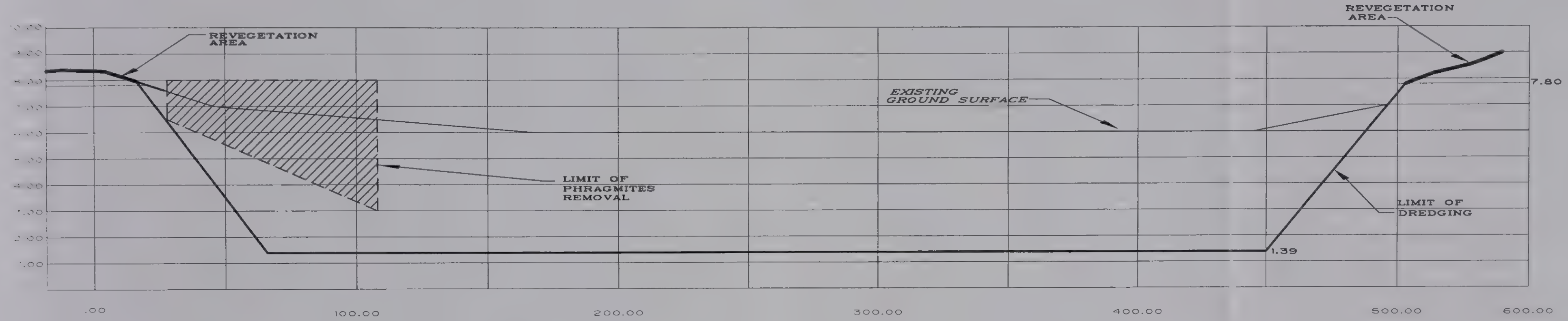
CROSS SECTION 6

AT STA 31+00

VERTICAL DATUM IS BOSTON CITY BASE (BCB)

Figure No. 6-9A

CROSS SECTIONS OF BANK REVEGETATION
AREAS IN THE BACK BAY FENS



CROSS SECTION 8A

AT STA 39+00

VERTICAL DATUM IS BOSTON CITY BASE (BCB)

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Figure No. 6-9B

CROSS SECTIONS OF BANK REVEGETATION AREAS IN BACK BAY FENS

bordering vegetated wetland would be altered in the process of restoration to future conditions.

Table 6-3
A Comparison of the Present and Proposed Future Extent of Resource Areas In The Back Bay Fens as Defined in 310 CMR 10.00

Resource Area	Present	Future
Bank	13,540 lf	13,540 lf
Land Under Water	16.2 acres	18.0 acres
Bordering Vegetated Wetland	0.4 acres	0.8 acres
Bordering Land Subject To Flooding	Not Determined	No Change
Riverfront Area	Not Determined	No Change

6.2.2.5 Ecological Functions and Values

The majority of vegetation in the Back Bay Fens is comprised of common reed (*Phragmites australis*). *Phragmites australis* (Common Reed or Giant Reed Grass) is a species of grass that grows up to 16 feet or more. Its flowering period is from late July to October. *Phragmites* competes successfully with many native species, quickly invading areas with its rhizomes and seeds. It is a shade-intolerant species and thus grows well on recently disturbed sites. Common reed is viewed in the northeast as a nuisance and classified as an exotic, invasive species. There is debate as to whether all strands are exotic species, or whether there is a strand native to the United States that may not be invasive.

Phragmites grows in both saltwater and freshwater areas. Although classified in Massachusetts as a wetland species (FACW+), it also can be found in uplands (usually in disturbed sites near wetlands), on filled areas that were previously wetlands, and on floating mats in deep water areas.

Reportedly, marsh birds use *Phragmites* for cover and for nesting. In addition, *Phragmites* stabilizes shoreline and has flood storage values. Muskrats, geese and insects use *Phragmites* as a food source.

Phragmites' disadvantages outweigh these advantages, however. Because it traps sediment and creates mats in deeper water habitats, it tends to restrict flow in rivers and streams. It also tends to create a monoculture, lacking diverse habitat and food value for animal life. While some wildlife species may use the *Phragmites* for habitat, other plant species create a more diverse habitat attractive to varied wildlife species. In addition, its stalks are slow to degrade, creating a thick mulch that prevents other vegetation from becoming established. Areas of dense stands, as in the Back Bay, are also a public heath risk and fire hazard. Other negative impacts include water quality degradation and blockage of visual access to the water. In the Back Bay Fens, thick *Phragmites* stands provide a shield for illicit activities according to the Boston Police Department.

The dredging activities proposed in the Back Bay Fens are described in Section 5.2. Flood conditions will be improved by a deepened channel and the removal of mats of *Phragmites.* These activities also will provide a more suitable fish habitat (i.e. cooler temperatures, reduction in sediment oxygen demand, increase of dissolved oxygen and the cycling of nutrients between the sediments, water and fish tissue). Dredging will remove organic sediments that are not conducive to fish spawning and expose more preferred granular materials.

After dredging activities are completed, invasive species such as purple loosestrife (*Lythrum salicaria),* common reed (*Phragmites australis*), and buckthorn (*Rhamnus sp.*), will be removed. The method of vegetation removal is described in Section 5. The area will be replanted with a mixture of historical wetland and upland vegetation as listed in Table 6-2. Landscaping plans are provided in Appendix I.

The removal of invasive vegetation (primarily *Phragmites*) along the bank and in the bordering vegetated wetlands (BVW) will benefit wildlife and provide soil and sediment control. Monotypic stands of *Phragmites* will be replaced with a diverse multi-species wetland/upland habitat. Replacement vegetation will benefit waterfowl and avian species as a source of food and cover. In addition, much of the emergent vegetation can provide nesting areas for fish species. The selected emergent species' extensive root systems will help stabilize soil, thereby preventing erosion and further siltation. Emergent vegetation will discourage the public from trampling these areas and will retard water velocity, helping to stabilize the bank. Examples of such species include sweet flag (*Acorus calamus*) and bur-reed (*Sparganium eurcarpum*). Emergent vegetation will be planted 12 inches on center. Banks and upland areas will be replanted with a mixture of historic wetland and upland plantings. Low shrubs such as *Xanthorhiza simplicissima* and *Rhus aromatica* will be planted 18 inches on center.

Wetland functions and values under proposed conditions were evaluated using the same methodology that was used to assess the existing conditions (see Section 4.3.2.5). The purpose of the Functions and Values Evaluation was to determine, in a non-biased manner, any ecological benefits that resulted from the proposed enhancement of the wetland, shoreline, and upland vegetation. The ecological benefits that result from the proposed project are shown in Table 6-4. The significance of the information in Table 6-4 is in the results of a comparison between the existing conditions (see Section 4.3.2.4 - Wetland Resources) and the proposed conditions. For the Back Bay Fens, there will be an overall increase in the ecological functions and values of flood flow alteration, fish habitat, sediment/toxicant retention, nutrient removal, product export, sediment/shoreline stabilization, wildlife habitat, and recreation.

Wetland Function-Value Evaluation Form

Total area of wetland______Human made?____Is wetland part of a wildlife corridor?___________or a "habitat island"?

Adjacent land use_Park__________________Distance to nearest roadway or other development_______________

Dominant wetland systems emergent Contiguous underdeveloped buffer zone present___NI_________

Is the wetland a separate hydraulic system?__No________If not, where does the wetland lie in the drainage basin?______

How many tributaries contribute to the wetland?___1______Wildlife & vegetation diversity/abundance (see attached list)

Wetland I.D.
Latitude______Longitude________
Prepared by:___JLG__Date_10/19/00
Wetland Impact:
Type______________Area_______
Evaluation based on:
Office__X__________Field______
Corps manual wetland delineation completed? Yes X____No_______

Function/Value	Occurrence Y	N	Rationale (Reference #)*	Principal Function(s)/Value(s)	Comments
Groundwater Recharge/Discharge		X	7,8		No evidence of groundwater discharge.
Floodflow Alteration	X		4,5,6,8,10,12,13,18	X	Dedging will improve flood retention.
Fish and Shellfish Habitat	X		4,6,7,12,14,17		Fish are present.
Sediment/Toxicant Retention	X		1,3,4,9,10,12*,14,15,16	X	Emergent vegetation will be as effective in trapping sediment as *Phragmties*.
Nutrient Removal	X		2,3,4,5,6,7,8,9,12,15	X	Wetland is able to trap nutrients from surrounding uplands.
Production Export	X		1,2,4*,7,8,12,13		Area will be replanted with high food value wetland plants.
Sediment/Shoreline Stabilization	X		3,4,8,9,12,13,14,15		Emergent vegetation and shrubs will stabilize banks and prevent erosion.
Wildlife Habitat	X		8,13,14,15,16*,19,20	X	A diverse mix of wetland vegetation in various vegetated layers will provide high wildlife habitat value.
Recreation	X		1,4,5*,7,8*,9,10,11,12,21		Area is used for passive recreation.
Educational Scientific Value	X		3,5,7*,9,10,11		Area is not used for educational purposes
Uniqueness/Heritage	X		1,2,4,5,7,11,12,13,14,15, 17,19		
Visual Quality/Aesthetics	X		1,2,4,7*,8		
ES Endangered Species Habitat		X			No endangered species reported in the area
Other					

*Refer to back up list of numbered considerations.

Notes: *=Restoration goals are designed to provide and enhance these functions and values.

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Table 6-4
Wetland Function-Value Evaluation Form for The Back Bay Fens

The 13 functions and values that are considered by the Regulatory Division for any Section 404 wetland permit are listed below. The list includes eight functions and five values. Values are grouped together at the end of the list.

These are not necessarily the only wetland functions and values possible. Not are they so precisely defined as to be unalterable. However, they do represent the best working 'palette' of descriptors, which can be used to paint an objective representation of the wetland resources associated with a proposed project.

Groundwater Recharge/Discharge--This function considers the potential for a wetland to serve as a groundwater recharge and/or discharge area. Recharge should relate to the potential for the wetland to contribute water to an aquifer. Discharge should relate to the potential for the wetland to serve as an area where groundwater can be discharged to the surface.

Floodflow Alteration (Storage & Desynchronization)--This function considers the effectiveness of the wetland in reducing flood damage by attenuation of floodwaters for prolonged periods following precipitation events.

Fish and Shellfish Habitat--This function considers the effectiveness of seasonal or permanent waterbodies associated with the wetland in question for fish and shellfish habitat.

Sediment/Toxicant/Pathogen Retention--This function reduces or prevents degradation of water quality. It relates to the effectiveness of the wetland as a trap for sediments, toxicants or pathogens.

Nutrient Removal/Retention/Transformation--This function relates to the effectiveness of the wetland to prevent adverse effects of excess nutrients entering aquifers or surface waters such as ponds, lakes, streams, rivers, or estuaries.

Product Export (Nutrient)--This function relates to the effectiveness of the wetland to produce food or usable products for human, or other living organisms.

Sediment/Shoreline Stabilization--This function relates to the effectiveness of the wetland to stabilize stream banks and shorelines against erosion.

Wildlife Habitat--This function relates to the effectiveness of the wetland to provide habitat for various types and populations of animals typically associated with wetlands and the wetland edge. Both resident and/or migrating species must be considered. Species lists of observed and potential animals should be included in the wetland assessment report.

Recreation (Consumptive and Non-Consumptive)--This value considers the effectiveness of the wetland and associated watercourses to provide recreational opportunities such as canoeing, boating, fishing, hunting and other active or passive recreational activities. Consumptive opportunities consume or diminish the plants, animals, or other resources that are intrinsic to the wetland, whereas non-consumptive opportunities do not.

Education/Scientific Value--This value considers the effectiveness of the wetland as a site for an 'outdoor classroom' or as a location for scientific research or study.

Uniqueness/Heritage--This value considers the effectiveness of the wetland or its associated waterbodies to produce certain special values. Special values may include such things as archeological sites, unusual aesthetic quality, historical events, or unique plants, animals, or geological features.

Visual Quality/Aesthetics--This value relates to the visual and aesthetic qualities of the wetland.

ES **Threatened or Endangered Species Habitat**---This value considers the effectiveness of the wetland or its associated waterbodies to support threatened or endangered species.

Source: ACOE

6.2.3 Cultural Environment

6.2.3.1 Historic Resources

The Boylston Street (Richardson) Bridge, the Stony Brook Gatehouse, Agassiz Bridge, and the building on Agassiz Road called the Duck House are extant features from the Primary Period of Significance. The second Gatehouse, Clemente Field and Field House and Rose Garden are extant from the Secondary Period of Significance. Two additional areas that are historic, but do not fall within the Periods of Significance are the Victory Gardens and WWI & WWII War Memorials. The historic structures and other character defining features of the Olmsted parkland will be protected so the impact to them will be minimal. During construction, the historic features and vegetation will be protected with chain link fencing as needed, including gated entries to the features to exclude construction activities. Protection fencing will remain in place until final completion of all proposed adjacent work and then the protected areas will be restored in kind as required. Entrance and egress to these features will be signed to control, direct, and protect pedestrian and vehicular access. Bridges will include protection as needed in addition to limits placed on dredging in the specification so as not to disturb footing structures.

The location of the path systems in the Back Bay Fens have varying integrity for the Secondary Period and a very small number of paths has integrity to the Primary Period. Paths are stone dust, bituminous and concrete in various locations with the paths that are stone dust having integrity of material. In addition, the path system at the area that was filled above The Fens Bridge and the entire path system in the filled Sears parking area will be rehabilitated under this contract when the these areas are daylighted.

The shoreline has been modified since both the Primary and Secondary Periods and will again be impacted by the work of this project. The dredging operations and removal of invasive vegetation will both impact the shoreline. Since access of dredging equipment to the water will be limited, the only areas that will be impacted by dredging equipment entering and exiting the water will be these selected points of entry. All dredging operations will be conducted from the water. *Phragmites* will be first cut down and removed from access points, but, where practical, removal of root masses will be from the water in a manner similar to the dredging operations. Areas that may be compacted by these operations will be aerated and restored upon completion of shoreline restoration and *Phragmites* removal.

The existing vegetation, except for heritage trees, has no historical integrity for either the Primary or Secondary Periods of Significance. The Rose Garden, even though it has design integrity as a feature, does not have specific plant species, which have historic integrity. The heritage trees will be protected to their drip line, pruned, and fertilized so impact to them should be minimal. During construction, historic structures and vegetation to be protected will be enclosed with protective chain link fencing, which will remain in place until final completion of all proposed adjacent work and then the protected areas will be restored in kind as required. In locations where there will be larger expanses of shoreline that is not to be disturbed, the entire area will be fenced off from construction.

The preservation of historic structures also includes the maintenance of bridges and the protection of the masonry from the effects of vegetation growing in the mortises. In February, 2001, the BPRD filed a Notice of Project Change for the cutting and removal of vegetation from the Agassiz Bridge and surrounding upland area. This maintenance and planting will start in 2002 and it is outside of the revegetation plans that are contained in Appendix I - Preliminary Design Report. The replanting at the bridge included plant materials from the 1988 planting plan. The MEPA Certificate indicated that no further MEPA review is required. The BPRD is consulting with the Boston Conservation Commission on the proposed plant removal and revegetation

6.2.3.2 Land Use

The current land use will be impacted during construction activity by increased traffic, noise, and dust. The presence of a staging area in the Back Bay Fens (Agassiz Road, the Lagoon, and Avenue Louis Pasteur) will result in a minor disturbance to use of this portion of the parkland. However, there will be neither an unacceptable short-term nor long-term impact to land use.

6.2.3.3 Recreation

Recreation in this area historically and currently has been heavily used for both active and passive including walking, sunbathing, bicycling, dog walking, etc. Treatment of this area under this project will retain the current active and passive recreation uses when the project is complete. During construction, there will be no interruption in use of Clemente Field or the basketball courts.

6.2.3.4 Pedestrian Access

The physical bounds of the two proposed staging areas (Lagoon and Fens at Louis Pasteur Staging Areas) will require temporarily closing several walking paths through the Back Bay Fens area. The key sidewalks adjacent to the travelway will remain open. Figure 6-2 presents the staging area bounds and the paths that will be temporarily closed.

6.2.4 Traffic

Table 6-5 documents the traffic that is expected to be generated by the staging areas. To reiterate, the traffic generated by each staging area and the culvert construction at the rotary is dependent on the level of productivity (i.e. the rate at which the sediment/earth is removed). If all operations are proceeding together, the highest trip generation would be 18 per hour. As recommended in Section 5, some culvert construction under Brookline Avenue at the former Sears parking lot would proceed at night, reducing the daytime trip to 16 per hour. The nighttime trip estimate of 2 trips per hour is an extremely low increase in traffic during low traffic periods.

Table 6-5
Trip Generation Estimate for Dredging and Culvert Construction
Muddy River Restoration

	Estimated Trips per Day (vpd)[1]				Estimated Trips per Hour (vph)[2]
Staging Area Traffic - Hydraulic Dredging	Haul Trucks (40-cy capacity)	Haul Trucks (20-cy capacity)	Contractor Work Trips / Material Delivery	Total (vpd)	Total
Enter	10	0	5	15	2
Exit	10	0	5	15	2
Total	20	0	10	30	4
Culvert Construction					
Enter	0	5	5	10	1
Exit	0	5	5	10	1
Total	0	10	10	20	2
Daylighting Construction					
Enter	0	40	5	45	6
Exit	0	40	5	45	6
Total	0	80	10	90	12

1. vpd - vehicles per day.
2. vph - vehicles per hour. Estimated assuming an 7-hour workday for staging area traffic and a 10-hour night time work shift for culvert construction. Hourly trip rates are rounded.

In general, these estimated increases in traffic volume are low, however, the area around the Sears Rotary is currently saturated with traffic during peak demand periods that would be sensitive to even small increases in traffic.

Table 6-6 indicates a deficiency at the intersection of Brookline Avenue at Boylston Street/Park Drive under existing and future conditions. The V/C ratios over 1.0 indicate that the demands through the intersection exceed the theoretical capacity, resulting in delays exceeding 80 seconds and LOS F operations. This occurs during the morning and evening peak periods. At the intersection of Brookline Avenue at The Fenway, capacity issues arise under future conditions in the morning peak hour. There were no deficiencies noted at the intersection of Park Drive at The Fenway /The

Riverway under existing or future conditions. Traffic diversions for the Back Bay Fens are illustrated in Figures 6-10, 6-11, and 6-12.

The culvert construction across The Riverway (at the former Sears parking lot) could be completed during the day in phases. The intersection of Park Drive at The Fenway/The Riverway operates at LOS B during both peak periods under existing conditions and LOS C under future conditions, resulting in the possibility of closing a lane of traffic. Table 6-5 indicates that a one-lane closure across The Riverway will no impact traffic operations provided signal timing and phasing adjustments are made. Across The Fenway, under existing demands, the one-lane closure is estimated to degrade intersection operations to LOS F without signal adjustments in the morning peak hour. With signal timing adjustments, this deficiency is corrected. Under projected 2007 traffic, signal timing adjustments are needed under both morning and evening peak periods. Across The Riverway, the one lane closure does not degrade operations to an unacceptable level.

Completing the culvert replacement across Brookline Avenue during the day given heavy traffic demands along Brookline Avenue would be very difficult. The link of Brookline Avenue between Park Drive and The Fenway is congested during the day resulting in operational issues at the adjacent intersections-especially at the Boylston Street/ Park Drive intersection. Based on an analysis of peak hour conditions at the rotary, even a one –lane closure along Brookline Avenue would significantly exacerbate the existing congestion.

Alternatives to daytime construction recommended in Section 5 would be a combination of daytime and nighttime work. By doing so, more aggressive lane closures and diversions can be implemented at night (see Figure 6-12). Brookline Avenue eastbound traffic can be diverted to the U-turn while construction is focused on Brookline Avenue (Phase 2). The westbound side of Brookline Avenue is relativel flat, allowing for the construction of temporary lanes when construction shifts to the westbound side of Brookline Avenue (Phase 3).

The heavy traffic demands present during the daytime also may occur during special events in the area, such as Red Sox games, "moving days" and commencement exercises. Construction activities would need to be coordinated and possibly curtailed during such periods of high demands.

Nighttime construction may potentially cause negative noise and disturbance impact to residents near the construction site. A combination schedule would allow construction outside of Brookline Avenue to occur during the day and the actual crossing during the nighttime. Nighttime work would include using drilled piles an vibratory sheeting between 7 and 11 p.m. to minimize noise impacts on nearby residents. No drilling or sheet piling would be conducted after 11 p.m.

In order to open and close lanes for nighttime construction, a temporary removable bridging slab would be constructed that would span the excavation during the

Table 6-6
Traffic Operations Impacts - Back Bay Fens Area (the Sears Rotary)

		xisting Demands (2000)			Future Demands (2007)		
CONDITIONS WITHOUT LANE CLOSURES:	Peak Hour	V/C*	Delay**	OS***	V/C	Delay	LOS
Brookline Avenue at Boylston Street/ Park Drive	Weekday Morning	1.07	> 80	F	1.18	> 80	F
	Weekday Evening	1.13	> 80	F	1.39	> 80	F
Brookline Avenue at The Fenway	Weekday Morning	0.93	31	C	1.17	69	E
	Weekday Evening	0.91	31	C	1.09	52	D
Park Drive at The Fenway and Riverway	Weekday Morning	0.41	17	B	0.51	22	C
	Weekday Evening	0.52	18	B	0.73	24	C
CONDITIONS WITH LANE CLOSURES: Park Drive at The Fenway and Riverway							
One-lane closure across The Fenway	Weekday Morning	0.69	>80	F	0.85	>80	F
	Weekday Evening	0.64	28	C	0.73	57	E
	Weekday Morning+	0.68	36	D	0.85	41	D
	Weekday Evening+	--	--	--	0.73	40	D
One-lane closure across The Riverway	Weekday Morning	0.46	17	B	0.56	22	C
	Weekday Evening	0.61	19	B	0.74	23	C

* V/C = volume-to-capacity ratio.
** Delay - Control delay per vehicle, expressed in seconds, includes initial deceleration delay, queue move-up time, stopped delay, and final acceleration delay..
*** LOS = level of service.
+ With signal timing adjustments
> 80 Delay cannot be calculated accurately when volume-to-capacity ratio exceeds 1.20 or 1/PHF.

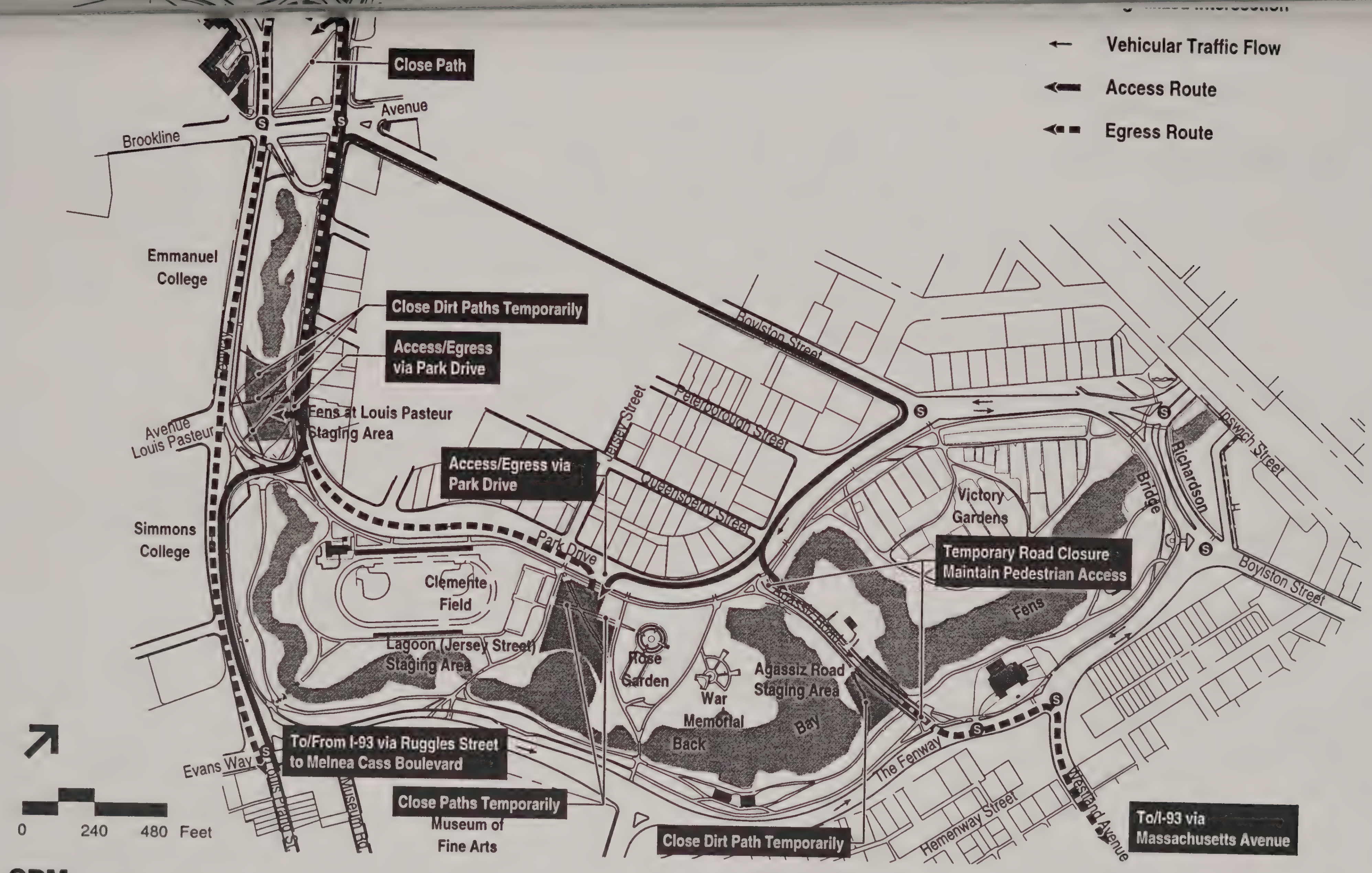

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Figure 6-10
Back Bay Fens Area Potential Staging Area Access/Egress Plan for Construction Traffic
Source: VHB, Inc.

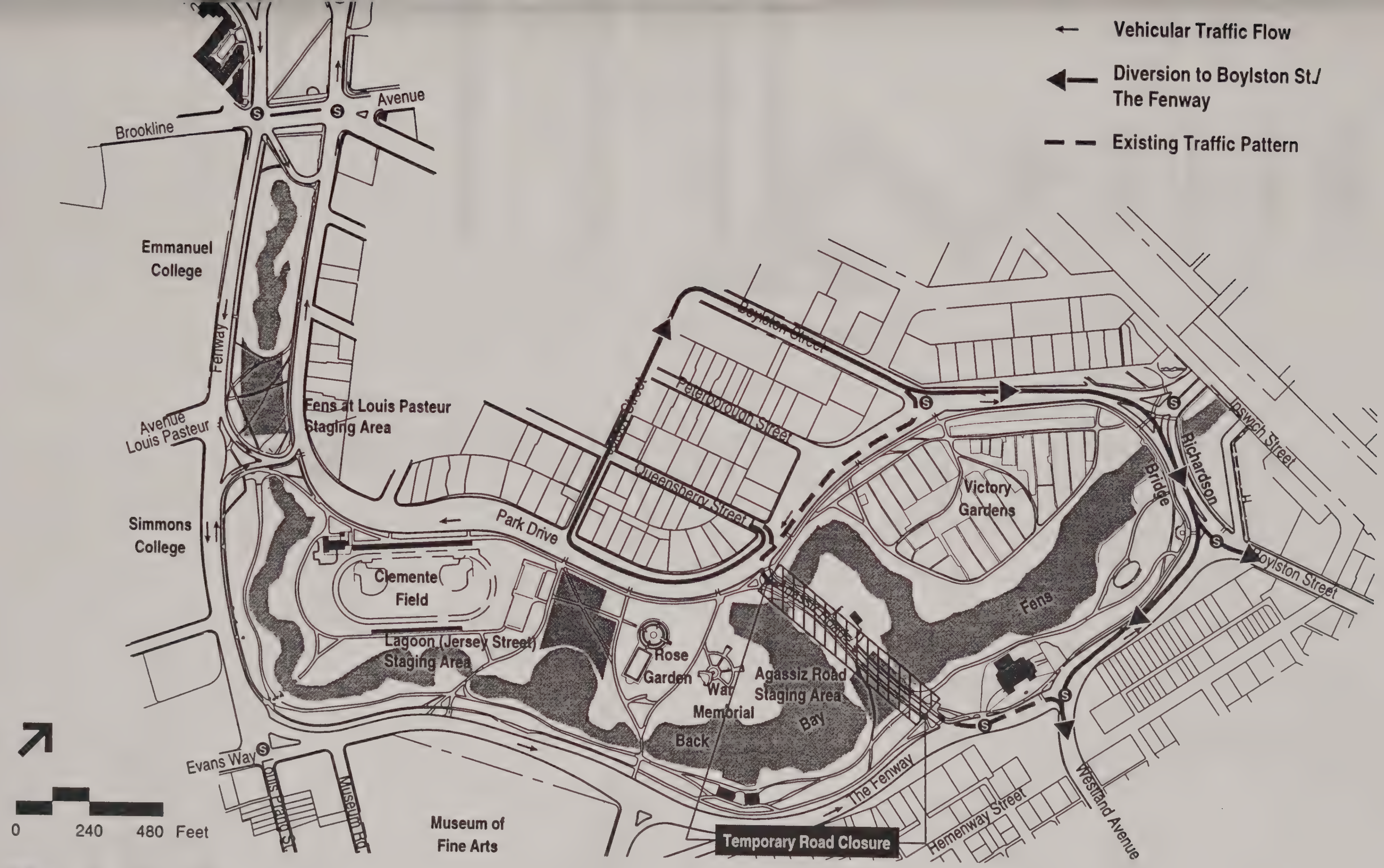

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Figure 6-11
Back Bay Fens Area Agassiz Road Traffic Diversions for General Traffic

Source: VHB, Inc.

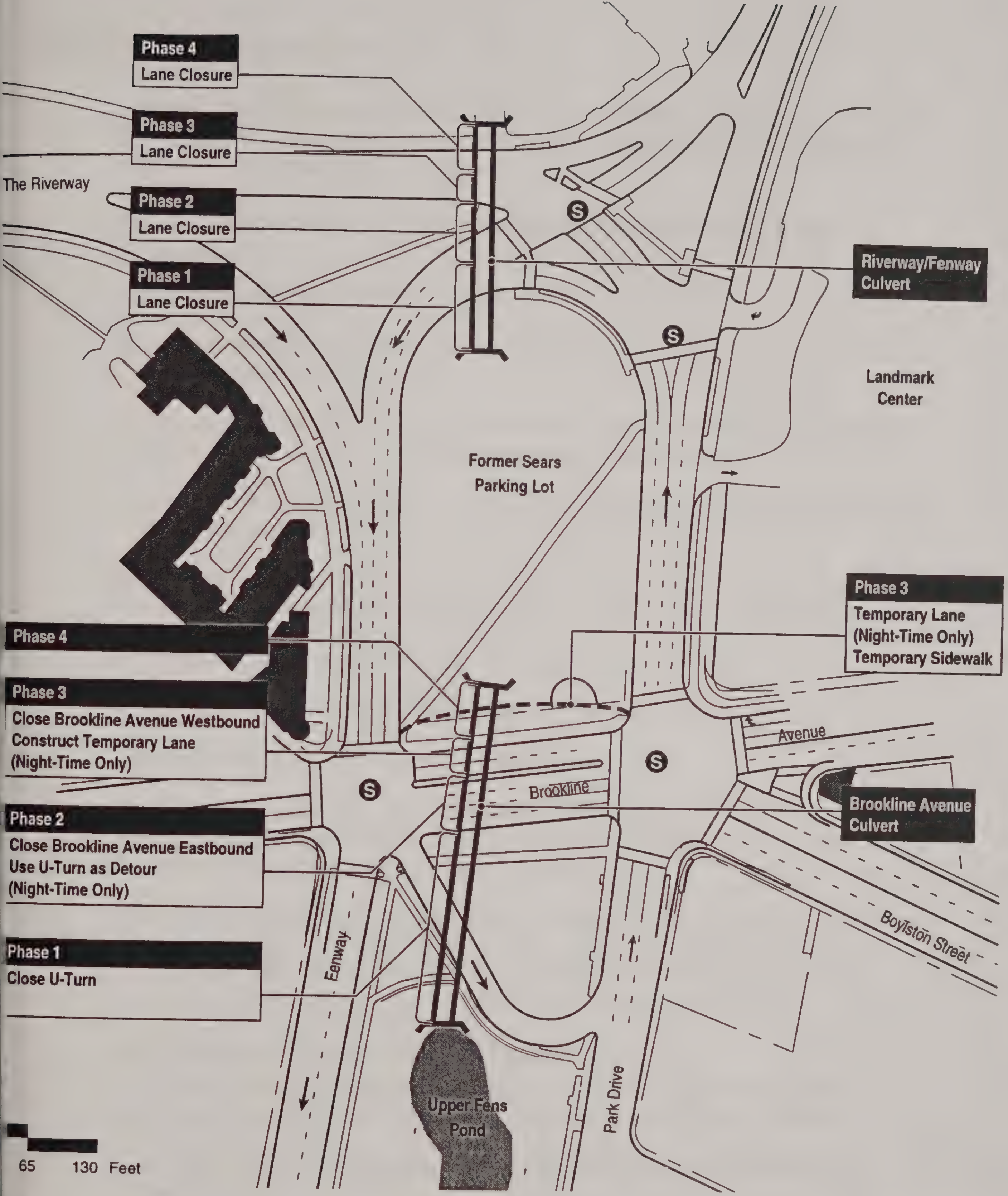

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Figure 6-12
Back Bay Fens Area Sears Rotary
Proposed Culvert Replacement
Implementation Plan
Source: VHB, Inc.

daytime. The slab would be removed by crane before night work begins and replaced before the next morning rush hour. This bridging slab would minimize impacts to daytime traffic, while allowing nighttime work to proceed.

6.3 Assessment of Environmental Impact in The Riverway

Construction activities that are proposed within The Riverway area include:

- The formation of one staging area for sediment dewatering equipment and the loading of sediment into trucks,
- The improvement of the flood carrying capacity via the dredging and removal of approximately 20,200 cy of accumulated sediment and debris,
- The preservation of the historic park shoreline through the removal of 10,000 cy of *Phragmites* and the restoration of the bank to its historic intent,
- The preservation of the historic park features by the re-vegetation of the new bank, and the establishment of wetland areas and masses of upland vegetation plantings,
- Re-vegetation of the staging areas upon completion of the work,
- The repair or replacement of worn pathways and denuded ground.
- Installation of new park benches and waste barrels.

The proposed construction and re-vegetation activities are discussed in Section 5.0 - A Description of the Project's Design and Construction, and the details are shown in the Preliminary Design Report provided in Appendix I.

The types of impacts that have been analyzed include those to be physical (hydrology, sediment, staging areas, etc), chemical (water quality), biological (benthic macroinvertibrates, insects, fish, birds, vegetation, etc.) and human (pedestrian movement, traffic, staging areas, park use, etc.) environmental elements.

6.3.1 Physical Environmental Features

A consistent goal of the Muddy River Project is to provide maximum possible environmental enhancement. In The Riverway, the proposed work includes:

- The enhancement of the habitat through the removal of monotypic stands of *Phragmites*,
- the stabilization of eroding or undercut banks,
- The planting of diverse species of wetland vegetation,
- The establishment of BMP's to improve water quality,

- The establishment of diverse masses of upland Olmsted shrubs and trees in the restored park configuration.

The physical environmental features in The Riverway will be disturbed temporarily during construction. Long-term physical alterations that are related to the removal of *Phragmites*, bank stabilization, and the enhancement of the aquatic and upland ecosystems to more natural ecosystems, will also occur. As shown in Figure 6-13, approximately 12,000 square feet (sf) of parkland at the Netherlands Road Bridge will be used for a temporary staging area. The site will be used for approximately 10 to 14 months, depending on the time of year it is closed and the growing season for re-vegetation.

The Netherlands Road staging area presently contains the roadway and bridge itself, fair grass ground cover, mature and younger trees, some shrubs, dense *Phragmites* along the shoreline, and paved and unpaved walkways.

The staging area will have a stable granular and well-drained work surface generally consisting of gravel layered over the existing grass and pavement. The staging area will contain sedimentation tanks, pumps, polymer feed systems, belt filter presses, water filters, conveyor belts and truck loading, a field office, and limited parking. The dredge(s) that is to be used will be lifted by crane or launched at accessible locations along The Riverway. All proposed work will be conducted from the staging area. Truck queuing will take place off-site and the trucks will be called to the site by radio/telephone. Therefore, the physical environment at the staging area will be temporarily altered from the vegetated and paved area that presently exists. As soon as the dredging in The Riverway section of the Muddy River that is being served by the Netherlands Road staging site is completed, the site will be restored and re-vegetated as shown in the Preliminary Design Report (see Appendix I).

Wetland plants will be planted all along The Riverway. Masses of upland vegetation will also be planted, resulting in a long-term and positive environmental benefit. This vegetation will result in the enhancement of the area's environmental bio-diversity.

Also, there will be extensive temporary piping for the hydraulic dredging placed through the park system. The piping will be placed in a manner that does not intrude with pedestrians using the paths. When paths and roadways need to be crossed, the pipes will be placed in shallow trenches and covered with asphalt/stone dust However, in order to minimize the amount of traffic disturbance, the pipes will be laid through the existing culverts and bridges whenever possible.

6.3.1.1 Hydrology

The hydraulic capacity of The Riverway is discussed in Section 4.4.1.1. The *Phragmites* that is growing in the vicinity of the Back Bay Yard, the island area and at other locations creates physical obstructions to the flow of water through The Riverway.

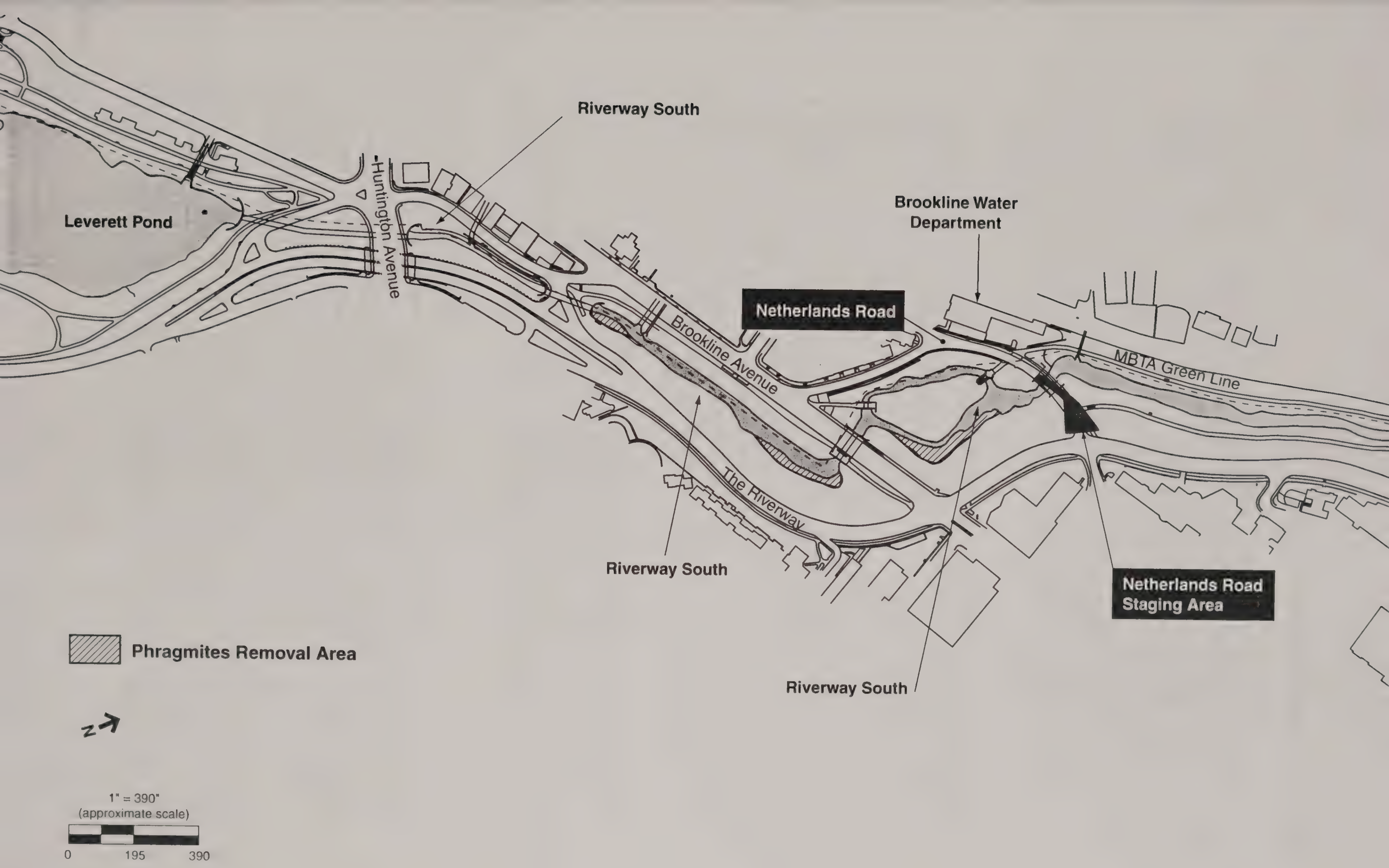

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Figure 6-13
Riverway South & Netherlands Road Staging Area

The growth of *Phragmites* in the island area has nearly totally blocked the primary flow channel along the Boston side and causes the majority of water to flow through a smaller and more confined channel along the Brookline side (see Plan No. 13 in Appendix B-Wetland delineation). Further downstream, closer to the Back Bay Yard, the *Phragmites* has also grown to such an extent that it is severely constricting the flow channel (see Plan No. 19 of Appendix B-Wetland Delineation). Therefore, in order to restore the flood carrying capacity of The Riverway, it is necessary to remove the *Phragmites* as well as the root mass that has extended well into watercourse. To minimize the amount of re-growth, it will also be necessary to remove the roots of Phragmites that extend up the bank.

It is very important to note that due to the improved flood carrying capacity in the Charlesgate and Back Bay Fens, the volume of water flow as well as the velocity of the water will increase. Figure 6-14 contains velocity profiles for the existing and improved conditions along The Riverway. As shown in the profiles, higher flow velocities are expected under the improved conditions than exist presently. The resulting flow velocities will have sufficient force to erode the existing sediments from The Riverway. The sediments would then migrate to, and ultimately settle in, the dredged Back Bay Fens. Therefore, so as not to compromise the flood capacity of the improved Charlesgate and Back Bay Fens, it is necessary to dredge the accumulated sediment from The Riverway to prevent the sediment from migrating downstream to dredged locations. Bank to bank dredging is necessary to eliminate flow restriction tat are caused by the Phragmites and to prevent the downstream migration of sediment into already dredged areas.

The Riverway section of the Muddy River will benefit greatly from the proposed downstream improvements. Figure 6-15 indicates that during the October 1996 storm, the Muddy River improvements allow the water level in the downstream end of The Riverway to be reduced about 5.3 ft from elevation 18.9 ft to 13.6 ft BCB. The upstream elevation near Route 9 is reduced about 4.0 ft from elevation 18.9 ft to 14.9 ft BCB.

6.3.1.2 Sediment Quality

Sediment that has accumulated in The Riverway, which is proposed to be removed (approximately 20,200 cy), consists of organic silt, intermixed with fine to coarse sand and gravel. The native underlying material consists of black-gray silt and sand, and some gravel (i.e., the remains of an estuary). Analytical results have indicated that the sediments contain primarily PAHs and arsenic, as well as, elevated concentrations of phosphorus (see Appendix F - Sediment Characterization). The sediment in The Riverway is highly organic and ranges in depth from 2-8 feet. Elevated concentrations of PAHs and arsenic were generally found in the top sediment layer and will be removed. Typically the concentrations of analytes decreased with depth. The results for PAHs suggest that the point source discharges along The Riverway could be a continuing source of contamination. Phosphorus concentrations generally increase in the down river direction and reaches the highest levels immediately prior

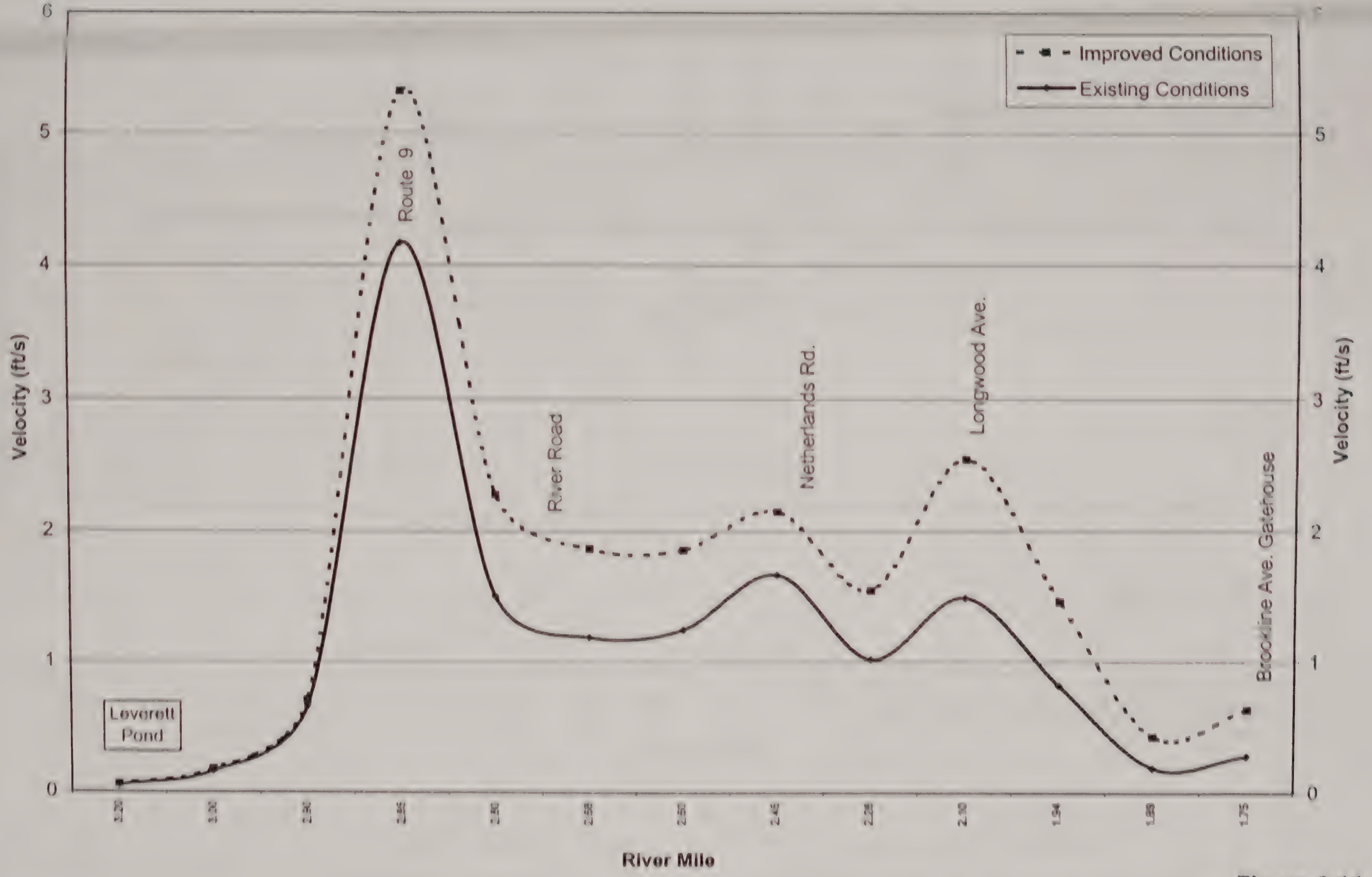


Figure 6-14
Simulated Velocities in the Riverway Section of the Muddy River
October 1996 Storm

CDM Camp Dresser & McKee Inc.

to the river bend and flow into the Back Bay Fens area. This part of the river may be an area of sedimentation due to lower flow velocity. The elevated levels of phosphorus in the fill sediment could be the result of particulate bound or dissolved phosphorus introduced via runoff and/or stormwater discharges in the area.

As stated above, for hydraulic reasons, it is only necessary to remove the *Phragmites* that is presently blocking the flow channel in The Riverway. Dredging of the watercourse in The Riverway itself is not necessary for hydraulic reasons. However, in order to prevent the downstream migration of sediment during periods of higher flow velocity, and to enhance the quality of sediment to which fish and wildlife are exposed as well as to improve water quality, the accumulated sediment in The Riverway will be removed. This accumulated sediment will be dredged to a depth of five feet, as shown in Figure 6-16. This will result in an improvement of river flow capacity, and the safeguard that the contaminated sediments in The Riverway will not migrate to downstream areas that have been dredged.

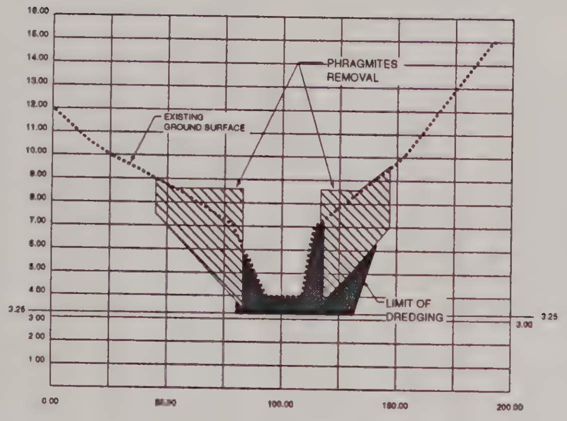
6.3.1.3 Water Quality

The water quality of the Muddy River through The Riverway is impacted by the quality of upstream water as the majority of water flow is derived from stormwater discharges. Water in The Riverway has been found to have exceedances of the water quality criteria for fecal coliform bacteria and dissolved oxygen. The river in this area is also enriched with nutrients that enhance algae and aquatic plant growth. Water quality data is included in Appendix G.

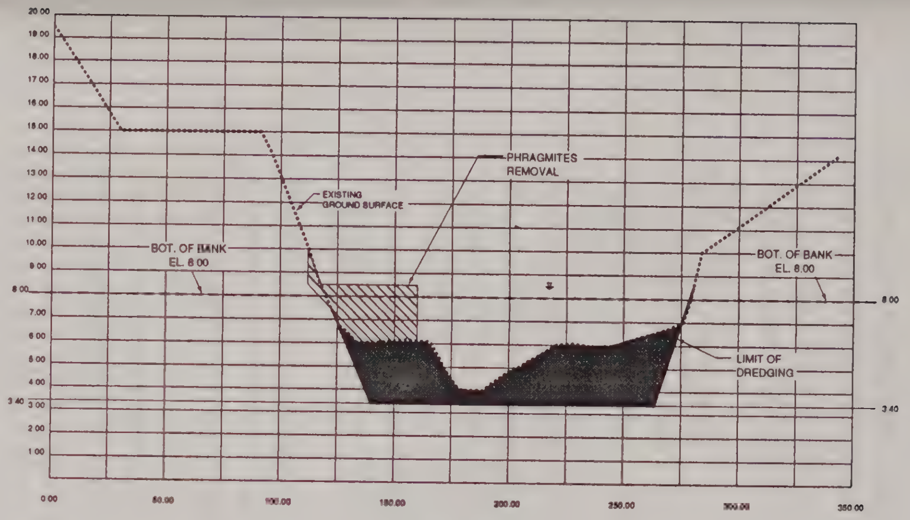
Long-term and short-term impacts to water quality will occur during the life of the Muddy River Project. The short-term negative impacts to water quality will be mitigated to a large extent by construction mitigation measures that are described in Section 7.0

Although much attention has been given to identifying and mitigating the short-term negative impacts to water quality from construction activities, one cannot loose sight of the significant and beneficial long-term impacts that will be derived from the Project. The long-term impacts to water quality will be beneficial in that:

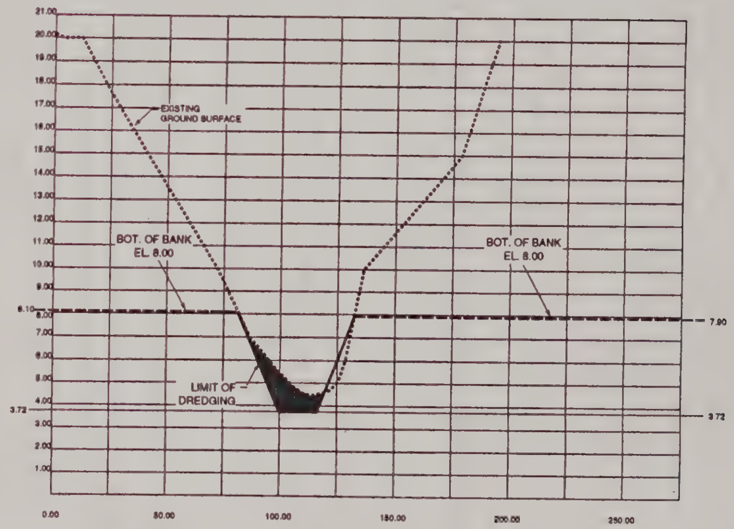
- The removal of the sediment will increase the flood flow capacity of the River,
- The removal of the contaminated sediment will enhance the quality of the River bottom for colonization by benthic organisms,
- The volume of the aquatic habitat will be substantially increased,
- The spawning habitat for fish will be improved,
- There may be an increase in the migration of anadromous fish, and
- The overall quality of the aquatic/riparian/upland habitat and its diversity will also be substantially improved.



SECTION 16
AT STATION 91+00



SECTION 18
AT STATION 101+20



SECTION 22
AT STATION 121+20

Boston City Base Datum (BCB)

Location of Cross Sections Shown on Figure 5-16

CDM Camp Dresser & McKee Inc.

Figure 6-16
Cross Sections of Riverway Dredging

During construction there will be at least three temporary sources of water to the Muddy River. These sources include 1) staging area runoff, 2) turbid water at the dredge and debris removal locations and floating debris, and 3) return water from the dredging and the belt filter presses processes.

Staging Area Runoff
In order to provide a workable surface, it is expected that the Contractor will form the staging area by placing a moderately dense layer of gravel and stone over the existing ground. In this manner the underlying soil will remain essentially undisturbed. Runoff will be controlled and the Contractor will be required to submit a Stormwater/Dewatering Pollution Prevention Plan (S/DPPP) for approval by the Project, DEP and the Boston and Brookline conservation Commissions before construction is allowed to proceed. The S/DPPP will contain an Erosion and Sedimentation Control Plan and a Spill Prevention Control and Countermeasure Plan for each staging area (see Section 7.0 - Mitigation Measures).

Turbid Water from the Removal of Root Mats, Dredging and Debris Removal
There will be a certain amount of unavoidable turbidity that is generated at the dredge site and locations where excavators must remove debris. This impact will be limited in duration, and due to the extremely low flow volume of the Muddy River, the lateral extent of this impact will be limited. Wherever possible, dredging area will be separated from that portion of the Muddy River where water is flowing by silt curtains in order to contain any turbidity. The monitoring of turbidity in Hardy Pond during hydraulic dredging operations indicated that there was minimal release of turbidity from the cutter head. It is proposed that the suspended solids limitations from the dredging be established at 200% of background concentrations at a distance of 200 feet from the dredge.

The removal of the stalks and root mats of *Phragmites* will be conducted in two steps. First the stalks will be cut, mulched and trucked from the site for composting. The second step will involve the removal of the root mat by an excavator from a barge or low impact aquatic equipment . Turbidity will be generated during excavation of the root mat. From this point the root mats will be removed to either a composting or disposal facility, as post-excavation testing indicates. Minimization and control of the turbid water will be conducted by deploying silt curtains that extend the full depth of the water column along the perimeter of he root mat. After allowing the excess water to drain from the bucket into the silt curtained-off excavation area, the excavator will then place the materials into a sealed truck. The truck will transport the root mat to the lagoon staging area to water in specially constructed roll-off containers that will allow excess water to drain form the materials. The excess water will drain into a sump from which it will be pumped into the fractionation tanks at the head end of the dewatering treatment process. In this manner, the turbid water will be contained along all steps of the excavation and handling process. The contact of turbid water from within the silt curtained-off excavation area and water flowing down the Muddy River will be minimized to the best extent possible. There may be some areas of The

Riverway (upstream of Netherlands Road) that are too narrow for the barge and a land-based excavator will be used.

Return Water from the Dredging and the Belt Filter Presses
The most efficient procedure to remove and treat the sediment for landfill management will be through the use of hydraulic dredging methods. The hydraulic dredging method includes a dredge that floats on pontoons and pumps that take in water through a rotating auger that cuts into the sediment. This results in the entrainment of the sediment with water.

From the dredge, the sediment slurry will be pumped to the staging area where it will be treated with a polymer and filtered through a belt filter press. The polymer enhances the separation of water from sediment and the result will be a high solids content filter "cake" that will be loaded into a truck by a conveyor. The low moisture filter cake will be removed from the site and transported to a suitable management/disposal facility. This water/sediment treatment process will produce a flow of water that will equal the amount of water that is pumped at the dredge. This return water will be filtered through a fine mesh mechanical filter prior to discharge to the Muddy River.

Best Management Practices
BMPs that are proposed for the Riverway include; the repair of sunken curbs and storm drain systems to prevent pavement runoff from overtopping curbs and prevent wash-outs and erosion, the installation of a particle separators at locations that are determined prudent as the result of the Pilot Study (see Sections 2 and 5), and the repair of erosion from desire lines and other sources of sediment. In addition, the BWSC is implementing the city-wide Boston Catch Basin Maintenance Program.

6.3.2 Biological Environment

The proposed Muddy River Project will result in the ultimate enhancement of the biological environment. This work includes enhancing the upland vegetation, wetlands, and aquatic and wildlife resources. However, in the course of conducting the dredging, construction and restoration work, temporary disturbances to the biological resources will result. The short-term and long-term impacts to the biological resources are included in the following sections.

6.3.2.1 Upland Vegetation and Horticultural Resources

The existing vegetation adjacent to the river and in the staging areas will be impacted (Appendix C documents vegetation). The Netherlands Road staging area will be approximately 12,000 sf and will be used for approximately 10 –14 months, depending on the time of the year that it sf closed and the next growing season when it can be re-vegetated. The removal of some vegetation will be required to accomplish the work of this project. In addition, the project plans call for the removal of *Phragmites*, glossy buckthorn, and Japanese knotweed that is growing in The Riverway. The shoreline areas where the bank is to be regarded and revegetated are shown in the Preliminary Design Report in Appendix I. The upland vegetation adjacent to the project areas, and upland vegetation within staging areas and access points, will be enclosed with chain link protection fences. The protected area will be restored in kind as required post-construction. At larger contiguous areas where the vegetation and bank are not to be disturbed, the entire areas will be fenced off from construction activities.

The bank restoration and re-vegetation process will be staged such that the extent of bare ground will be minimized at any point in time. Silt fencing will be placed and maintained along all areas to be disturbed. As soon as bank re-grading work in an area is completed, the soil in the area will be tilled and aerated and will either be sodded or mulched with pine bark in advance of the planting of vegetation. Sod will be pegged into the ground on slopes greater than 3:1. The wetland shelf will also be planted as soon after re-grading as possible.

When a staging area is to be restored, the crushed stone base will be removed and the loam ground restored including tilling and aeration. The surrounding silt fencing, however, will remain until grass is growing. Only then will it be removed and the ground where the fence had been will be raked level and seeded. Seeding will be conducted by hydromulching. In the event that a staging area is to be closed outside of the growing season, the crushes stone base, site security, and siltation fencing will remain in place until the next growing season. Complete site restoration will be conducted within the first two months of the growing season.

6.3.2.2 Aquatic and Wildlife Resources

The existing aquatic and wildlife resources in The Riverway are limited by the lack of diversity of plants and habitat structure. The Muddy River in this area supports a warm water fishery that includes bottom-feeding species, pan fish, forage species and some predatory fish such as bass. Blue back herring may migrate through this river section. The benthic resources (bottom inhabiting organisms) are pollution tolerant. The wildlife resources include urban species that have adapted to high levels of interference and a less than natural habitat with limited diversity. See Section 4 for existing resources.

Benthic Resources

The benthic resources will be the most severely impacted aquatic community from the dredging. There will be a near total loss of these species, which are dominated by pollution tolerant organisms. Benthics will take a number of years to repopulate because the upstream benthic pool will also be reduced. However, in weighing the negative and positive aspects of this loss, the value of the bottom food chain versus the planktonic food chain needs to be considered. Bottom feeding fish such as goldfish, suckers, and carp do not contribute in a positive manner to fish populations nor water quality. Bottom feeding fish substantially contribute to the murkiness of the water, nutrient levels, and algae growth by agitating the sediments, re-solubilizing nutrients into the water, promoting the growth of less desirable blue-green algae upon which zooplankton cannot feed, and damaging spawning nests of other fish.

This results in negative water quality impacts that also produces a negative impact on the zooplankton and the food chain for pan fish and game fish. A fishery resource that is based on plankton for food is often considered to be more desirable than a dominating bottom food source.

In fishery management, it is a common practice to reclaim water bodies of undesirable species including the bottom dwellers. Following fish reclamation, water clarity improves, nutrient concentrations are reduced, the growth of blue-green algae decreases, and an increase in the extent of spawning nests for pan fish and game fish increases. Under the present conditions in the Muddy River, the bottom dwelling fish resource is dominant, and is undesirable due to its adverse effect on water quality and magnification of contaminants in the food chain. The dredging will not result in a sterilization of bottom resources. Some benthic organisms will be kicked aside by the turbulence of the dredging and remain to grow and reproduce. There also will be a continual reintroduction of worms and midges from other upstream areas, including the unaffected portion of the "Babbling Brook", undredged parts of Wards Pond, Spring Pond, and storm drains that are not affected by the dredging operation.

Fish Resources

During dredging there will be some mortality of fish. The loss may be proportionally higher in the bottom dwelling species than the open water species. This impact is not considered adverse, however, because the water quality of the Muddy River would benefit from substantially fewer bottom dwelling species, which cause the cycling of nutrients and the contamination of the river.

The removal of sediment from The Riverway will result in an enhanced aquatic habitat for fish resources. The removal of contaminated sediment will lead to improved dissolved oxygen and less nutrient and contaminant cycling from the sediments to the water. The removal of hydrocarbon compounds (DDT and PCBs) will also reduce the content of contaminants in edible fish tissue, thereby reducing bio-accumulation through the food chain. It is also anticipated that within a free flowing and deeper water column, combined with daylighted sections of the river, anadromous fish migration will increase.

Wildlife Resources

The positive long-term effects to wildlife resources in The Riverway will outweigh the temporary negative impacts. Minimal disturbance to avian species likely will occur during dredging and re-vegetation operations as the birds relocate to areas of less disturbance. The planting of larger areas of trees and shrubs may attract greater numbers of birds after the construction has been completed. In locations where dredging occurs during winter hibernation, amphibian and reptile species will be less likely to relocate and some percentage will be lost.

There will also be an active rodent control program (see Section 7.0 - Environmental Mitigation Plan) that is intended to control as much rodent displacement as possible during the dredging.

The re-vegetation of The Riverway will result in a substantial increase of habitat diversity as the result of an improved composition of the aquatic, wetland, shrub and tree canopy components of the ecosystem. The proposed planting plan and extent of planting is shown in detail in the Preliminary Design Report contained in Appendix I. (Figure L-1 to L-50). Figures 6-17 and 6-18, taken from the Preliminary Design Report, are illustrations of the typical plant massing that are proposed for The Riverway in the Netherlands Road and Island area. The proposed shrub and tree species that are listed in Table 6-2 were selected from the original Olmsted design. Because the Muddy River was a tidal estuary when Olmsted prepared his design, it was necessary to select freshwater wetland plants that would grow in today's freshwater environment. The list includes 20 species of shrubs and tress from the original Olmsted planting list, six species of shoreline plants, and 11 species of emergent wetland plants. There is no plan to introduce submersed aquatic species because they will colonize the aquatic environment as seeds are introduced by waterfowl and upstream sources. Figure 6-19 contains a cross section of the dredged Riverway near the island at Netherlands Road showing the proposed re-vegetation. Typical bank details are shown on Figure 5-11 and 5-12.

An active rodent control program will be enacted (see Section 7.0 – Environmental Mitigation Plan) to control as much rodent displacement as possible during the dredging. In order that the goose problem that exists at Leverett Pond does not become relocated to the Riverway, there will be a multi-faceted program for goose control. This is described in Section 8 - Management and Maintenance.

6.3.2.3 Rare Species

The Riverway area does not contain any rare, threatened or endangered species.

6.3.2.4 Wetland Resources

The Riverway area contains monotypic stands of *Phragmites* that have established extensive mats into the watercourse resulting in the restriction of the flood carrying capacity of the Muddy River. The *Phragmites* also has extended up the bank and dominated much of the bordering vegetated wetland resources.

The proposed work includes the total removal of the *Phragmites*, including the extensive root system, and the introduction of plant species that are listed in Table 6-2. Where one species dominates the present ecosystem, six species of shoreline plants and eleven species of emergent plants will replace it. This will result in a substantial enhancement of the functions and values of the aquatic, wetlands, and upland ecosystems ,as well as a commensurate enhancement in wildlife functions and values.

Table 6-7 contains a comparison of the present and future extent of the wetland resource areas. In accordance with the Wetland Protection Act, most of the bank and bordering vegetated wetland would be altered in the process of restoration to future conditions.

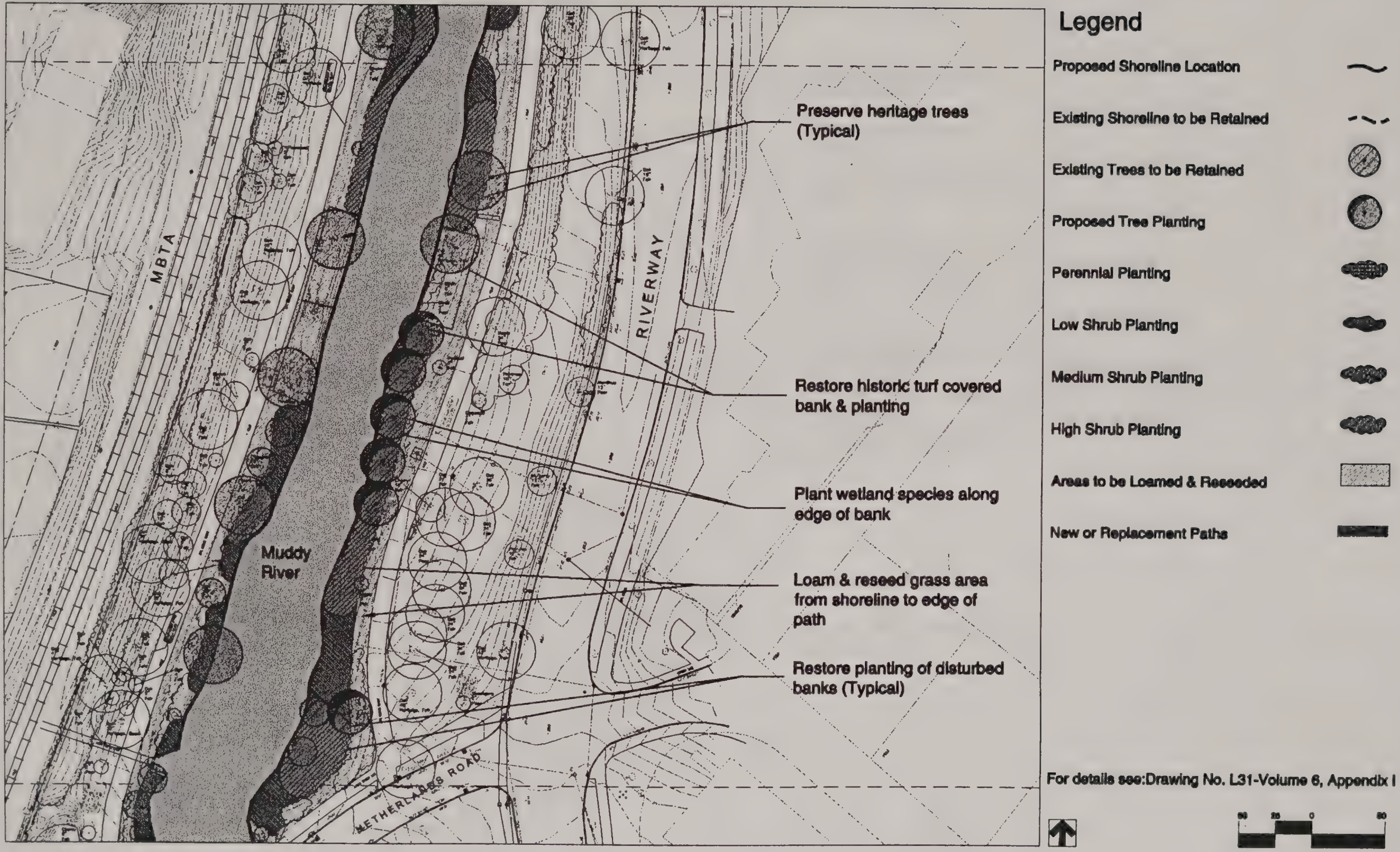

MBTA
Muddy River
RIVERWAY
NETHERLANDS ROAD
Preserve heritage trees (Typical)
Restore historic turf covered bank & planting
Plant wetland species along edge of bank
Loam & reseed grass area from shoreline to edge of path
Restore planting of disturbed banks (Typical)
Legend
Proposed Shoreline Location
Existing Shoreline to be Retained
Existing Trees to be Retained
Proposed Tree Planting
Perennial Planting
Low Shrub Planting
Medium Shrub Planting
High Shrub Planting
Areas to be Loamed & Reseeded
New or Replacement Paths
For details see:Drawing No. L31-Volume 6, Appendix I
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Figure 6-17

Typical Plant Massing Proposed for the Riverway, Netherlands Road Area

Source: Pressley, Inc.

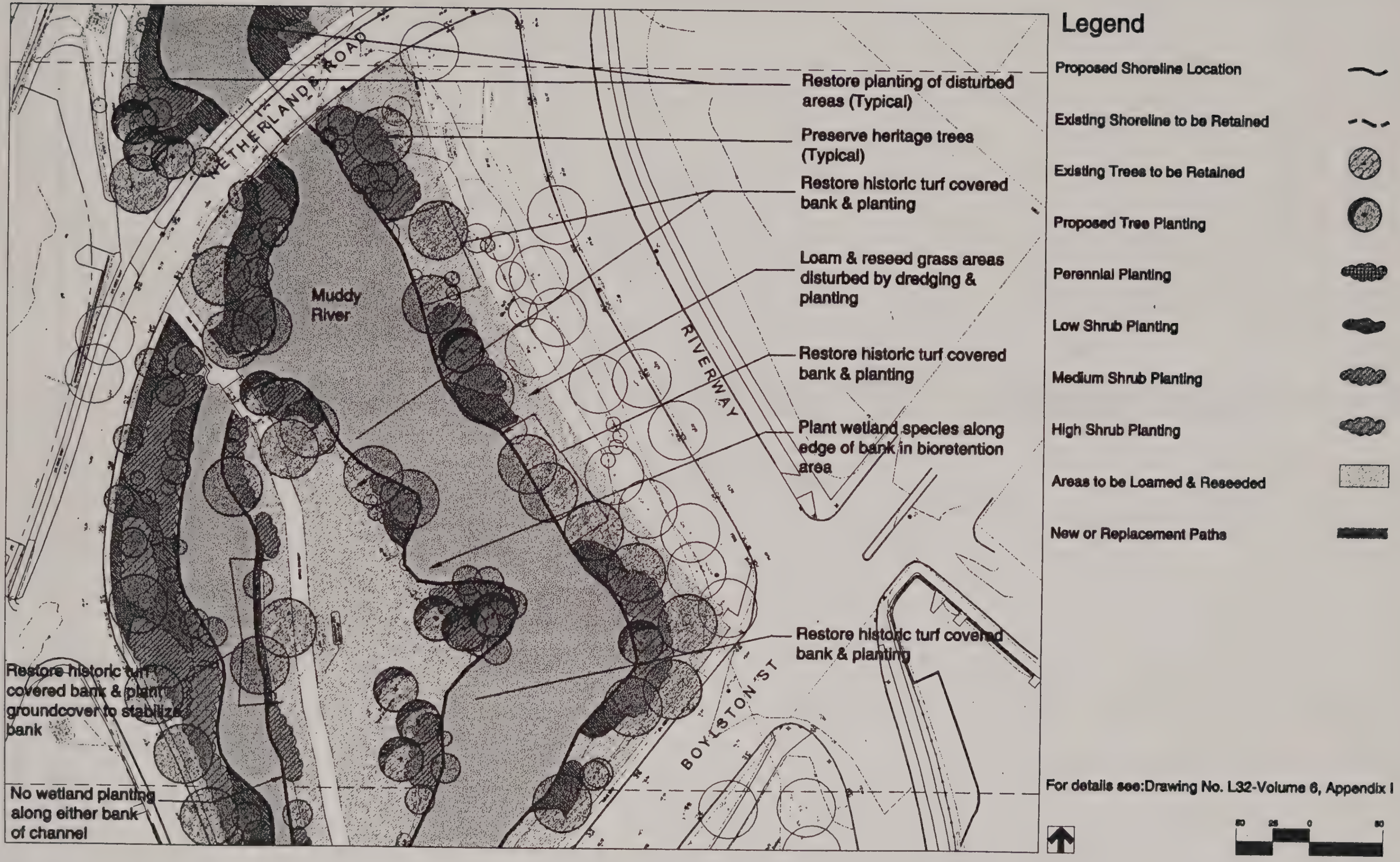
Restore planting of disturbed areas (Typical)
Preserve heritage trees (Typical)
Restore historic turf covered bank & planting
Loam & reseed grass areas disturbed by dredging & planting
Restore historic turf covered bank & planting
Plant wetland species along edge of bank in bioretention area
Restore historic turf covered bank & planting
Restore historic turf covered bank & plant groundcover to stabilize bank
No wetland planting along either bank of channel
NETHERLANDS ROAD
RIVERWAY
BOYLSTON ST
Muddy River
Legend
Proposed Shoreline Location
Existing Shoreline to be Retained
Existing Trees to be Retained
Proposed Tree Planting
Perennial Planting
Low Shrub Planting
Medium Shrub Planting
High Shrub Planting
Areas to be Loamed & Reseeded
New or Replacement Paths
For details see:Drawing No. L32-Volume 6, Appendix I
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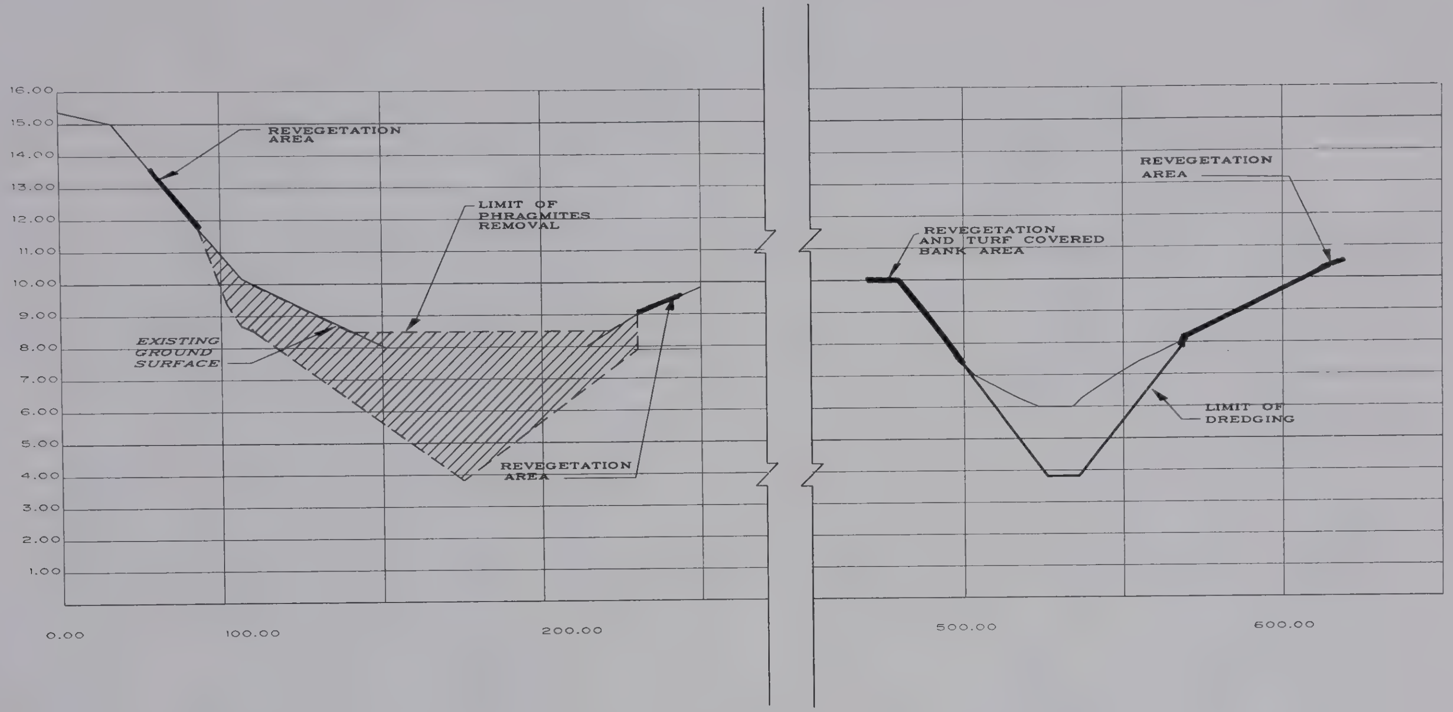
Figure 6-18
Typical Plant Massing Proposed for the Riverway, Island Area
Source: Pressley, Inc.



CROSS SECTION 24

AT STA 128+90

VERTICAL DATUM IS BOSTON CITY BASE (BCB)

Figure No. 6-19

CROSS SECTIONS OF BANK REVEGETATION
AREAS IN THE RIVERWAY

Table 6-7

A Comparison of the Present and Proposed Future Extent of Resource Areas In The Riverway as Defined in 310 CMR 10.00

Resource Area	**Present**	**Future**
Bank	12,670 lf	12,670 lf
Land Under Water	9.4 acres	9.4 acres
Bordering Vegetated Wetland	0.7 acres	0.6 acres
Bordering Land Subject To Flooding	Not Determined	No Change
Riverfront Area	Not Determined	No Change

6.3.2.5 Ecological Functions and Values

The proposed dredging activities in the Riverway are described in Section 5.3. The proposed dredging will deepen the channel and remove *Phragmites* to provide better flood control. These activities will also provide an improved fish habitat (i.e. cooler temperatures, reduction in sediment oxygen demand, increase of dissolved oxygen, and the cycling of nutrients between the sediments, water and fish tissue). Dredging will remove organic sediments not conducive to fish spawning and will expose more preferred granular materials. After dredging activities are completed, invasive species such as purple loosestrife (*Lythrum salicaria)*, common reed (*Phragmites australis*), and buckthorn (*Rhamnus sp.*), will be removed. The vegetation removal method to be employed is described in Section 5. The area will be re-planted with a mixture of historical wetland and upland vegetation as listed in Table 6-2. Landscaping plans are provided in Appendix I. It is intended that the public will access The Riverway (boating, fishing, etc.) via a designated restored historic turf covered bank rather than vegetated wetland areas of better wildlife habitat.

The removal of nuisance aquatic vegetation (primarily *Phragmites*) along the bank and in the bordering vegetated wetlands (BVW) will benefit wildlife and will provide soil and sediment control. Monotypic stands of *Phragmites* will be replaced with a diverse multi-species wetland/upland habitat. Replacement vegetation will benefit waterfowl and avian species as a source of food and cover. In addition, much of the emergent replacement vegetation will provide nesting areas for fish species. The selected emergent species' extensive root systems will help stabilize soil, thereby preventing erosion and further siltation. Emergent vegetation will discourage the public from trampling these areas and will retard water velocity, helping to stabilize the bank. Examples of such species include sweet flag (*Acorus calamus*) and bur-reed (*Sparganium eurcarpum*). Emergent vegetation will be planted 12 inches on center.

Banks and upland areas will be re-planted with a mixture of historic wetland and upland plantings. Low shrubs such as *Xanthorhiza simplicissima* and *Rhus aromatica* will be planted 18 inches on center.

Wetland functions and values under proposed conditions were evaluated using the same methodology that was used to assess the existing conditions (see Section 4.4.2.5). The purpose of the Functions and Values Evaluation was to determine, in a non-biased manner, any ecological benefits that resulted from the proposed enhancement of the wetland, shoreline, and upland vegetation. The ecological benefits that result from the proposed project are shown in Table 6-8. The significance of the information in Table 6-8 is in the results of a comparison between the existing conditions (see Section 4.4.2.4 - Wetland Resources) and the proposed. For The Riverway, there will be an overall increase in the ecological functions and values of flood flow alteration, fish habitat, sediment/toxicant retention, nutrient removal, product export, sediment/shoreline stabilization, wildlife habitat, and recreation

6.3.3 Cultural Environment

6.3.3.1 Historic Resources

The Chapel Street Station footbridge and contiguous Bridle Path Bridge, Round House Shelter, Carlton Street MBTA Bridge, Longwood Avenue Bridge, Netherlands Road Bridge, and the two pedestrian footbridges between Netherlands Road and Brookline Avenue are extant features from the Primary Period of Significance. These historic structures and other parkland features will be protected so impact to them will be minimal. Bridges will include protection as needed in addition to limits placed on dredging in the specifications so as not to disturb footing structures.

The location of the path system on either side of the Muddy River retains integrity to the Primary Period, but is bituminous on the Brookline side and stonedust on the Boston side.

The shoreline has collapsed, eroded, been undermined and has been modified by placement of riprap and paved drainage channels since the Primary Period of Significance. The bank to bank dredging of The Riverway will impact the shoreline. The shoreline has been modified since both the Primary and Secondary Periods and will again be impacted by the work of this project. The dredging operations and removal of invasive vegetation will both impact the shoreline. Since access of dredging equipment to the water will be limited, the only areas that will be impacted by dredging equipment entering and exiting the water will be these selected points of entry. All dredging operations will be conducted from the water. *Phragmites* will be first cut down and removed from access points on the land side, but all removal of root masses will be from the water in the same manner as the dredging operations. Areas that may be compacted by these operations will be aerated and restored upon completion of shoreline restoration ad *Phragmites* removal.

The existing vegetation, except for heritage trees, has limited historical integrity for the Primary Period of Significance. The heritage trees will be protected, pruned, and fertilized so impact to them should be minimal. Upland vegetation that has been

Total area of wetland______Human made?____Is wetland part of a wildlife corridor?___________or a "habitat island"?

Adjacent land use_Park____________________Distance to nearest roadway or other development_______________

Dominant wetland systems Shrub Contiguous underdeveloped buffer zone present___Nl_________

Is the wetland a separate hydraulic system?__No________If not, where does the wetland lie in the drainage basin?______

How many tributaries contribute to the wetland?___1______Wildlife & vegetation diversity/abundance (see attached list)

Wetland I.D.
Latitude______Longitude________
Prepared
by·___JLG__Date_10/19/00
Wetland Impact:
Type______________Area_______
Evaluation based on:
Office__X__________Field______
Corps manual wetland delineation
completed? Yes X____No_______

Function/Value	Occurrence Y	Occurrence N	Rationale (Reference #)*	Principal Function(s)/Value(s)	Comments
Groundwater Recharge/Discharge		X	7		No evidence of groundwater discharge.
Floodflow Alteration	X		4,5,9,12	X	Wetland is able to retain some flood water.
Fish and Shellfish Habitat	X		3,4,6,8,12,17		Fish are present.
Sediment/Toxicant Retention	X		1,3,4,8,9,10,16	X	Wetland is effective in trapping sediments from runoff waters.
Nutrient Removal	X		2,3,4,6,7,8,9,12	X	Wetland is able to trap nutrients from surrounding uplands.
Production Export	X		1,2,8,12		Wetland contains little useable food for living organisms
Sediment/Shoreline Stabilization	X		1,3,5,6,8,9,12,13		Phragmities are effective in stabilizing the bank.
Wildlife Habitat	X		10,14,15,16*,19*,20*	X	Mono-ecosystem, does not provide a diversity for wildlife habitat.
Recreation	X		4,7,8,9,10,12		Area is used for passive recreation.
Educational Scientific Value		X	3,5*,8,9,10,11,12		Area is not used for educational value
Uniqueness/Heritage		X	1,2,4,5*,8,11,12,15,16,17		
Visual Quality/Aesthetics		X	1,2,4,7*,8		
ES Endangered Species Habitat		X			No endangered species reported in the area
Other		X			

*Refer to back up list of numbered considerations.

Notes: *=Restoration goals are designed to provide and enhance these functions and values.

Table 6-8
Wetland Function-Value Evaluation Form for The Riverway

The 13 functions and values that are considered by the Regulatory Division for any Section 404 wetland permit are listed below. The list includes eight functions and five values. Values are grouped together at the end of the list.

These are not necessarily the only wetland functions and values possible. Not are they so precisely defined as to be unalterable. However, they do represent the best working 'palette' of descriptors, which can be used to paint an objective representation of the wetland resources associated with a proposed project.

Groundwater Recharge/Discharge--This function considers the potential for a wetland to serve as a groundwater recharge and/or discharge area. Recharge should relate to the potential for the wetland to contribute water to an aquifer. Discharge should relate to the potential for the wetland to serve as an area where groundwater can be discharged to the surface.

Floodflow Alteration (Storage & Desynchronization)--This function considers the effectiveness of the wetland in reducing flood damage by attenuation of floodwaters for prolonged periods following precipitation events.

Fish and Shellfish Habitat--This function considers the effectiveness of seasonal or permanent waterbodies associated with the wetland in question for fish and shellfish habitat.

Sediment/Toxicant/Pathogen Retention--This function reduces or prevents degradation of water quality. It relates to the effectiveness of the wetland as a trap for sediments, toxicants or pathogens.

Nutrient Removal/Retention/Transformation--This function relates to the effectiveness of the wetland to prevent adverse effects of excess nutrients entering aquifers or surface waters such as ponds, lakes, streams, rivers, or estuaries.

Product Export (Nutrient)--This function relates to the effectiveness of the wetland to produce food or usable products for human, or other living organisms.

Sediment/Shoreline Stabilization--This function relates to the effectiveness of the wetland to stabilize stream banks and shorelines against erosion.

Wildlife Habitat--This function relates to the effectiveness of the wetland to provide habitat for various types and populations of animals typically associated with wetlands and the wetland edge. Both resident and/or migrating species must be considered. Species lists of observed and potential animals should be included in the wetland assessment report.

Recreation (Consumptive and Non-Consumptive)--This value considers the effectiveness of the wetland and associated watercourses to provide recreational opportunities such as canoeing, boating, fishing, hunting and other active or passive recreational activities. Consumptive opportunities consume or diminish the plants, animals, or other resources that are intrinsic to the wetland, whereas non-consumptive opportunities do not.

Education/Scientific Value--This value considers the effectiveness of the wetland as a site for an 'outdoor classroom' or as a location for scientific research or study.

Uniqueness/Heritage--This value considers the effectiveness of the wetland or its associated waterbodies to produce certain special values. Special values may include such things as archeological sites, unusual aesthetic quality, historical events, or unique plants, animals, or geological features.

Visual Quality/Aesthetics--This value relates to the visual and aesthetic qualities of the wetland.

ES **Threatened or Endangered Species Habitat**---This value considers the effectiveness of the wetland or its associated waterbodies to support threatened or endangered species.
Source: ACOE

planted under recent projects and trees and shrubs that are adjacent to the work will be protected so impact on them should be minimal. During construction, vegetation to be protected will be enclosed with protective chain link fencing that will remain in place until final completion of all proposed adjacent work and then the protected areas will be restored in kind as required.

6.3.3.2 Land Use

The presence of a staging area in The Riverway will result in a minor disturbance to use of this portion of the parkland. However, there will not be an adverse short-term nor long-term impact to land use. The current land uses surrounding the site will not be affected by the work of this project.

6.3.3.3 Recreation

Recreation in this area historically and currently has been both active (walking, biking, jogging) and passive. Treatment of this area under this project will retain the current active and passive recreation uses when the project is complete. The use of some active and passive areas will be restricted at different times during construction so entrance and egress to the area will be signed to control, direct, and protect pedestrian access during construction. As much as possible, the access to pathways will be kept open.

6.3.3.4 Pedestrian Access

There are no planned temporary sidewalk or path closures in The Riverway area. At the Netherlands Road Staging Area, although the roadway will be temporarily closed to traffic, pedestrian access will be maintained along the roadway, as noted on Figure 6-18. Netherlands Road is not a heavy through pedestrian route, however, the roadway serves a residential area that generates some pedestrian activity along Netherlands Road. Pedestrian counts indicate that there were approximately 50 pedestrians using Netherlands Road during the evening peak hour.

Pedestrians access along the pathways on the east and west sides of the Riverway will not be affected during construction except for possible temporary detours if construction access is needed. These impacts have been reviewed by BPRD and Brookline, and are acceptable.

6.3.4 Traffic

Figures 6-20 and 6-21 present the point of access/egress to the Netherlands Road Staging Area and the truck routes to regional destinations. With the proposed temporary closure of Netherlands Road and the desired regional truck route to Route 9 via Brookline Avenue, the project will impact operations at the intersection of The Riverway at Brookline Avenue. This impact is the result of added traffic to the intersection, primarily by eliminating Netherlands Road as a bypass of The Riverway/Brookline Avenue intersection for general traffic. In the morning, an estimated additional 495 vehicles will enter the intersection, an increase of 14 percent

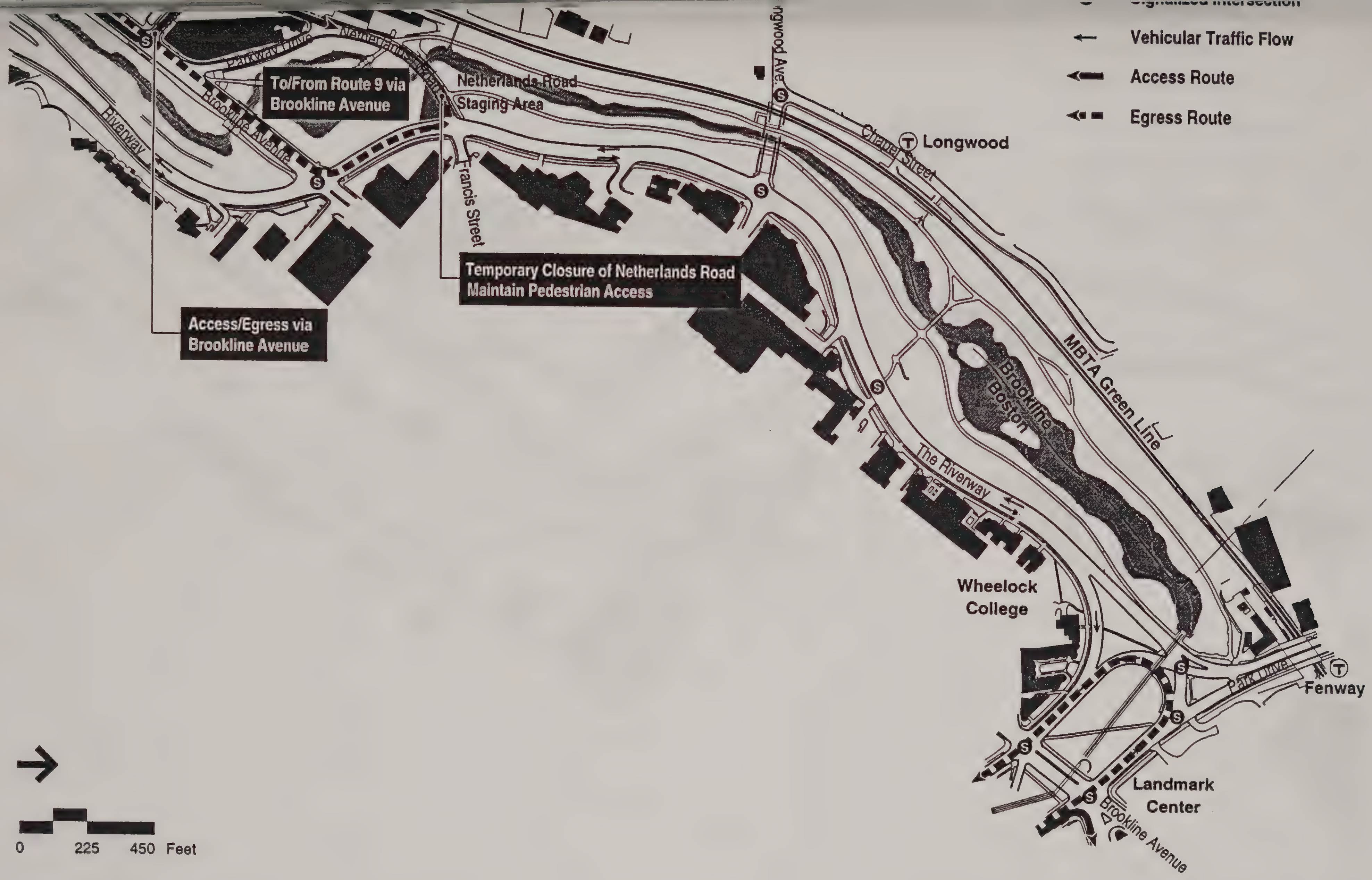


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Figure 6-20
Riverway Area Potential Staging Area Access/Egress Plan for Construction Traffic
Source: VHB, Inc.

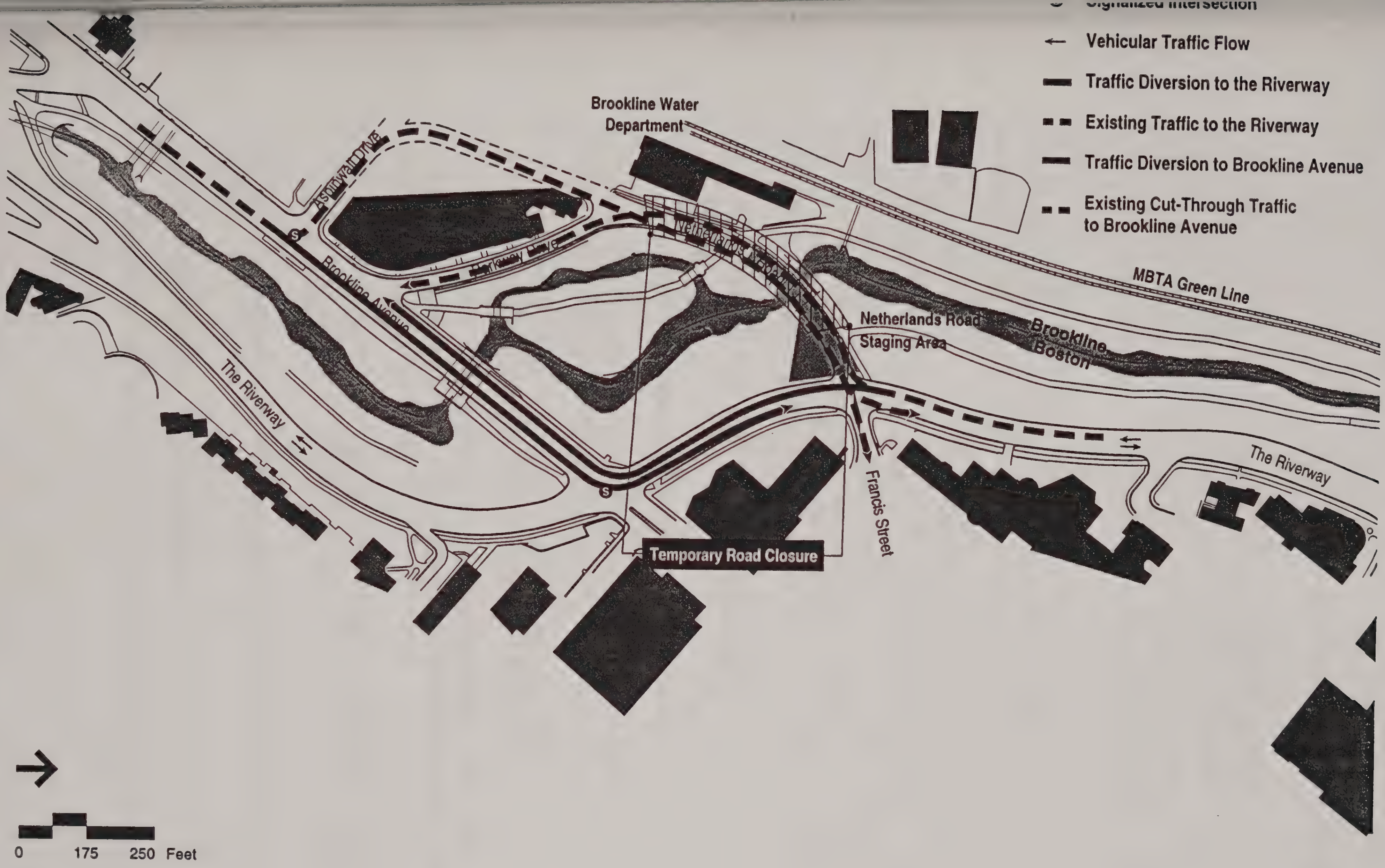

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Figure 6-21
Riverway Area Netherlands Road
Traffic Diversions for General Traffic

Source: VHB, Inc.

over existing volumes. The evening peak hour traffic volume increase is approximately 435 vehicles, an 11 percent increase. Table 6-9 provides a summary of the traffic operations under no-build conditions and proposed conditions with the temporary closure of Netherlands Road while this staging area is active. Traffic operations are presented in terms of level-of-service (LOS). Similar to a report card, LOS designations range from LOS A (free flow, low delays) to LOS F (forced flow, high delays).

The capacity results in Table 6-2 indicate several operational issues, most of which are existing deficiencies. The poor operation of The Riverway northbound approach is an existing condition. The proposed road closure is not expected to add traffic to this approach. In the southbound direction, there is an estimated addition of 360 vehicles added to an already oversaturated approach (LOS F under existing conditions). Along Brookline Avenue, both left-turns operate at LOS F under both peak hours. Under existing conditions, the eastbound left-turn operates at LOS D under morning peak hour conditions. Similar to the existing conditions, the overall intersection operates at LOS F. As indicated, LOS degradation from the project is expected to occur at the left-turns on both Brookline Avenue approaches. Mitigation of this impact would include possible lane designation changes as well as traffic signal timing/phasing changes.

6.4 Assessment of Environmental Impact in Leverett Pond

Construction activities that are proposed within the Leverett Pond area include:

- The formation of one staging area for sediment dewatering equipment and the subsequent loading of sediment into trucks,
- The improvement of the flood carrying capacity via dredging and removal of approximately 23,900 cubic yards (cy) of accumulated sediment,
- The preservation of the historic park shoreline through the restoration of the bank to its historic intent and the enhancement of the view corridor associated with the re-orientation of the Daisy Field backstop/playing field,
- The preservation of the historic park features through the re-vegetation of the new bank and an island, and the establishment of wetland areas and masses of upland vegetation plantings,
- Protection of the habitat on the three islands with dense and humanly inaccessible habitat,
- Stabilization of the eroding banks on the islands,
- Restoration of the Babbling Brook at the inlet to Leverett Pond from Willow Pond,

Table 6-9

Traffic Operations Impacts - Riverway Area (closure of Netherlands Road)

	Morning Peak Hour			Evening Peak Hou	
CONDITIONS WITHOUT ROADWAY CLOSURE	**Demand[1]**	**Delay[2]**	**LOS[3]**	**Demand**	**Delay**
Riverway Northbound					
Left / Through	950	80	F	765	80
Right	620	33	C	240	13
Riverway Southbound					
Through / Right	640	36	D	1,240	>80
Brookline Avenue Eastbound					
Left	150	49	D	140	>80
Through / Right	420	37	D	400	43
Brookline Avenue Westbound	275	56	E	490	>80
Left	390	24	C	690	29
Through / Right					
Entire Intersection	3,445	>80	F	3,965	>80
CONDITIONS WITH ROADWAY CLOSURE					
Riverway Northbound					
Left / Through	950	>80	F	765	>80
Right	620	33	C	240	13
Riverway Southbound					
Through / Right	765	38	D	1600	>80
Brookline Avenue Eastbound					
Left	350	>80	F	170	>80
Through / Right	580	41	D	410	43
Brookline Avenue Westbound	275	>80	F	490	>80
Left	400	24	C	725	29
Through / Right					
Entire Intersection	3,940	>80	F	4,400	>80

[1] Demand per lane group, expressed in vehicles per hour
[2] Average control delay, expressed in seconds per vehicle.
[3] Level-of-Service

- Re-vegetation of the staging area upon completion of the work,
- The repair or replacement of worn pathways and denuded ground, and
- The installation of new park benches and waste barrels

The proposed construction and re-vegetation activities are discussed in Section 5.0 - A Description of the Project's Design and Construction. Details are shown in the Preliminary Design Report that is contained in Appendix I.

The types of impacts that have been analyzed include those to physical (hydrology, sediment, staging areas, etc), chemical (water quality), biological (benthic macroinvertebrates, insects, fish, birds, vegetation, etc.) and human (pedestrian movement, traffic, staging areas, park use, etc.) environmental elements.

6.4.1 Physical Environmental Features

A consistent goal of the Muddy River Project is to provide as much environmental enhancement as possible. At Leverett Pond, the proposed work includes the enhancement of the habitat through the stabilization of eroding or undercut banks, the planting of diverse species of wetland vegetation, the establishment of BMP's to improve water quality, the establishment of diverse masses of upland Olmsted shrubs and trees, the re-vegetation of a denuded island, the stabilization of eroding banks around the islands, and the protection of wildlife habitat on the islands with dense vegetation.

The physical environmental features in the Leverett Pond will be altered temporarily during construction. Positive long-term physical alterations that are related to bank stabilization, measures to minimize the presence of geese (see Section 8), deepening of the water body, and the enhancement of the aquatic and upland ecosystems to more natural ecosystems are expected.

As shown in Figure 6-22, approximately 45,000 square feet (sf) of Daisy Field will be utilized as a temporary staging area. The staging area will be use for approximately 14 to 16 months, depending on the time of year that it is closed and the next growing season when it will be re-vegetated. The Daisy Field staging area presently contains two baseball diamonds with associated backstops and lighting, a small-unpaved parking area, good grass ground cover, mature and younger trees, shrubs in the woodland areas, and unpaved walkways. The proposed staging area layout will only impact one ballfield, the southerly Little League fill will remain in use during construction. The staging area will contain a stable granular and well-drained work surface generally consisting of gravel layered over the existing grass and pavement. The staging area will contain sedimentation tanks, pumps, polymer (a coagulant) feed systems, belt filter presses, water filters, conveyor belts for truck loading, a field

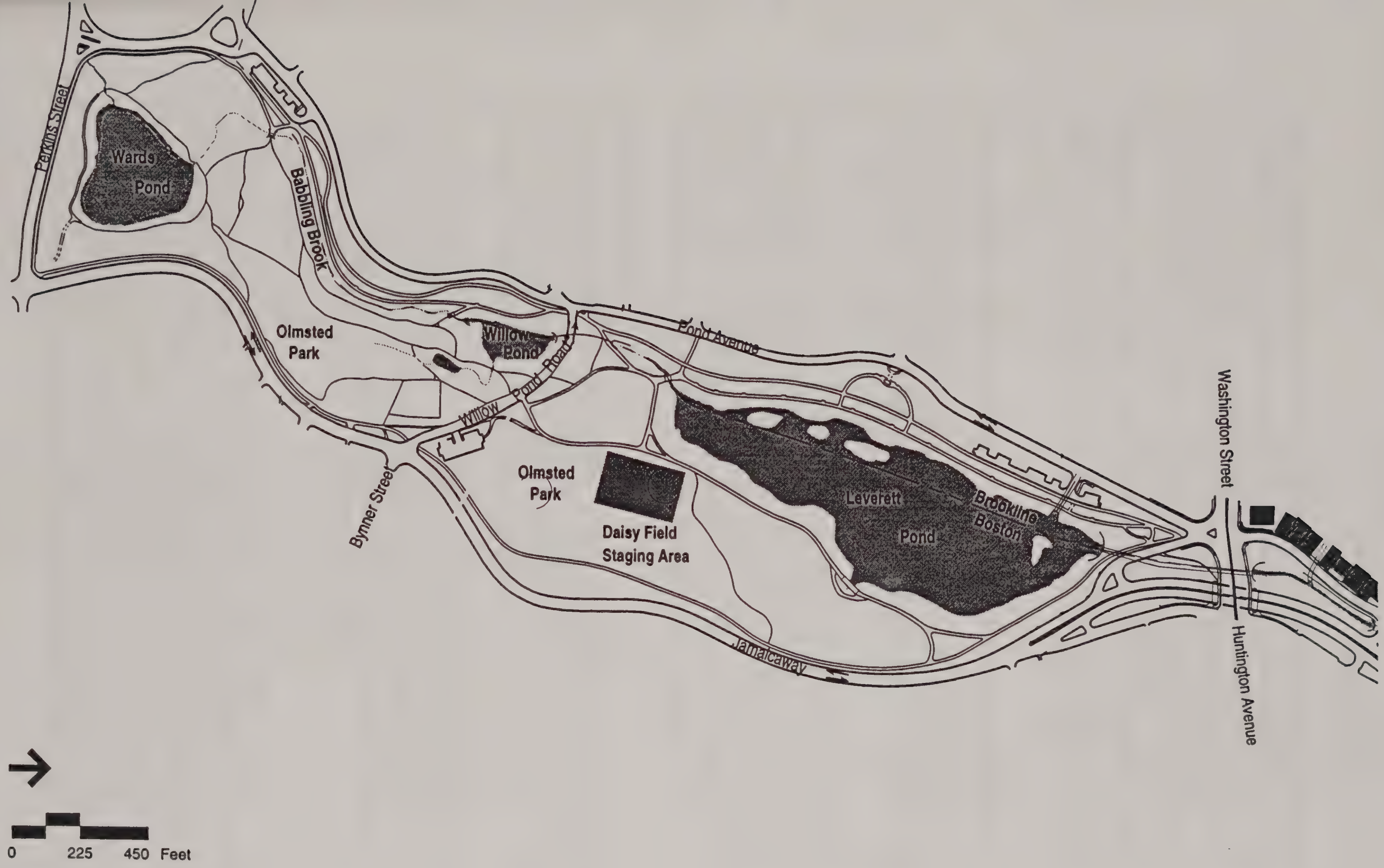

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Figure 6-22
Leverett/Willow/Wards Pond Area
Potential Staging Area
Access/Egress Plan

Source: VHB, Inc.

office, and limited construction personnel parking. All work will be conducted from the staging area. Truck queuing will occur off-site and the trucks will be called to the site by radio/telephone. The dredge will either be lifted into the pond with a crane or launched from an appropriate location on the bank. Therefore, the physical environment at the staging area will be temporary altered from the vegetated and paved area that presently exists. The Daisy Field staging area will service the dredging of Leverett Pond, Willow Pond, and Wards Pond. The staging area's re-vegetation will be conducted as soon as seasonal conditions permit after the dredging of the three water bodies is completed as shown in the Preliminary Design Report (see Appendix I).

Dense wetland and shoreline plants will be planted around Leverett Pond to discourage the entry of geese from the water onto the park upland as well as to enhance the aquatic and upland habitat around the Pond., thereby resulting in a long-term and positive environmental benefit. This will also result in the enhancement of the area's environmental diversity.

There will also be extensive temporary piping for the hydraulic dredging will be placed through the park system. The piping will be placed in a manner that does not intrude with pedestrians using the paths. When paths and roadways need to be crossed, the pipes will be placed in shallow trenches and covered with asphalt/stone dust. However, in order to minimize the amount of traffic disturbance, the pipes will be laid through the existing culverts and bridges whenever possible.

6.4.1.1 Hydrology

The hydraulic capacity of Leverett Pond is discussed in Section 4.5.1.1. The main hydraulic restriction stems from the Village Brook Drain where the accumulated sand bar restricts the free flow of high storm water from the drain. This results in localized flooding of the adjacent roadways and residences.

The improvements proposed for downstream sections of the Muddy River will also provide a benefit for the water level reached in Leverett Pond during the October 1996 storm. Figure 6-15 shows the simulated maximum water levels in Leverett Pond for both the existing and proposed conditions. Under the improved conditions, the level is reduced about 3.3 ft from elevation 19.4 ft to 16.1 ft BCB.

6.4.1.2 Sediment Quality

Sediment that has accumulated in Leverett Pond, which will be removed (approximately 23,900 cy), consists of black organic silt, intermixed with fine to coarse sand and gravel. The native underlying material consists of black-gray fine to medium sand and silt. The sediments contain PAHs, lead and arsenic (see Appendix F - Sediment Characterization). The concentrations of analytes were higher in samples collected from the center to the outlet of Leverett Pond with the highest concentrations found along the centerline. Based on the proposed dredging depths, it is likely that elevated concentrations of PAHs and arsenic in sediment will remain in this area. Elevated concentrations of PAHs found in samples collected near the Village Brook drain suggest that this may be a continuing source of contaminants. The levels of phosphorus in the fill sediment could be the result of particulate bound or dissolved phosphorus introduced via runoff and/or stormwater discharges containing animal and waterfowl fecal matter or from point source discharges in the area.

Approximately 1.5-2.0 feet of sediment in Leverett Pond will be removed, including the sand bar. The dredging of Leverett Pond will not necessarily result in a positive impact on flood storage capacity because the dredging is taking place below the flood level. Dredging will, however, have a positive impact on water quality because of the reduction in the cycling of nutrients and other contaminants.

6.4.1.3 Water Quality

Because stormwater comprises the bulk of water flowing through Leverett Pond, the water quality of the Muddy River at this location is impacted by the quality of water from the Village Brook Drain, the Daisy Field Drain, and the Chestnut Street Drain. Water in Leverett Pond has been found to have exceedences of the water quality criteria for fecal coliform bacteria and dissolved oxygen, and the water is also enriched with nutrients, which can cause the growth of algae and aquatic plant. See Appendix G for water quality data.

Long-term and short-term impacts to water quality will occur during the life of the Muddy River Project. The short-term negative impacts to water quality in Leverett Pond will be mitigated to a large extent by construction mitigation measures that are described in Section 7.0. The removal of contaminated sediment will reduce sediment oxygen demand and will improve dissolved oxygen and decrease nutrient and contaminant cycling from the sediments to the water. In order to enhance long-term water quality of the Muddy River, a Best Management Practices (BMP) program (see Section 5.7-Best Management Practices), and water quality monitoring program (see Section 7.0-Environmental Mitigation Plan) will be implemented. Although there is much discussion regard the short-term negative impacts to water quality from construction activities, one cannot loose sight of the significant and beneficial long-term impacts that will be derived from the Project. The long-term impacts to water quality will be beneficial in that:

- The removal of the sediment will increase the flood flow capacity of the River,
- The removal of the contaminated sediment will enhance the quality of the River bottom for colonization by benthic organisms,
- The volume of the aquatic habitat will be substantially increased,
- The spawning habitat for fish will be improved,
- There may be an increase in the migration of anadromous fish, and

- The overall quality of the aquatic/riparian/upland habitat and its diversity will also be substantially improved.

During construction there will be at least three temporary sources of water to the Muddy River. These sources include 1) staging area runoff, 2) turbid water at the dredge and debris removal locations and floating debris, and 3) return water from the dredging and the belt filter presses processes.

Staging Area Runoff
In order to provide a workable surface, it is expected that the Contractor will form the staging area by placing a layer of crushed stone over the existing ground. In this manner the compaction and erosion of the underlying soil will be minimized. Runoff will be controlled and the Contractor will be required to submit a Stormwater/Dewatering Pollution Prevention Plan (S/DPPP) before construction is allowed to proceed. The S/DPPP will contain an Erosion and Sedimentation Control Plan and a Spill Prevention Control and Countermeasure Plan for each staging area (see Section 7.0 - Mitigation Measures).

Turbid Water From Dredging and Debris Removal
There will be a certain amount of unavoidable turbidity that is generated at the dredge site and locations where excavators must remove debris. This impact will be limited in duration, and due to the extremely low flow volume of the Muddy River, the lateral extent of this impact will be limited. Wherever possible, dredging area will be separated from that portion of the Muddy River where water is flowing by silt curtains in order to contain any turbidity. The monitoring of turbidity in Hardy Pond during hydraulic dredging operations indicated that there was minimal release of turbidity from the cutter head. For the purpose of establishing a limitation on the suspended solids that are generated from the dredging, it is proposed that the suspended solids in Leverett Pond not to be greater than 200% of background concentrations at a distance of 200 feet from the dredge.

Return Water from the Dredging and the Belt Filter Presses.
The most efficient procedure to remove and treat the sediment for landfill management will be through the use of hydraulic dredging methods. The hydraulic dredging method includes a dredge that floats on pontoons and pumps that take in water through a rotating auger that cuts into the sediment. This results in the entraining of the sediment with water.

From the dredge, the sediment slurry will be pumped to the staging area where it will be treated with a polymer and filtered through a belt filter press. The polymer enhances the separation of water from sediment and the result will be a high solids content filter "cake" that will be loaded into truck by a conveyor. The low moisture filter cake will be removed from the site and transported to a suitable management/disposal facility. This water/sediment treatment process will produce a flow of water of approximately 200 gpm. This return water will be filtered through a fine mesh mechanical filter prior to discharge to the Muddy River.

It is proposed that the return water contain a total suspended solids (TSS) concentration of 50 milligrams per liter (mg/l) and a maximum daily limit of 100 mg/l. In order for the Contractor to receive approval to proceed with the work, a DMMP will be prepared and submitted for approval by both the DEP and the BCC. Water quality monitoring of the return water as well as that in the Muddy River will also be implemented. Further details on the outline of the DMMP are contained in Section 7.0 - Environmental Mitigation Plan.

Best Management Practices
A particle separator is proposed for Daisy Field drain outlet based on the outcome of the pilot study. The realignment of the baseball diamond will also reduce sediments from surface runoff from reaching Leverett Pond. The water quality in Leverett Pond will also be enhanced as the result of the upstream measures that are planned for the Chestnut Street Drain as well as the Pilot Study that is presented in Sections 2 and 5. In addition, the BWSC is implementing the city-wide Boston Catch Basin Maintenance Program that will also have a positive impact on the water quality entering Leverett Pond via the Daisy Field drain.

6.4.2 Biological Environment

The proposed Muddy River Project will result in the ultimate enhancement of the biological environment. This work includes the upland vegetation, wetlands, and aquatic and wildlife resources. However, in the course of conducting the dredging, construction and restoration work, there will be temporary disturbances to the biological resources. The short-term and long-term impacts to the biological resources are included in the following sections.

6.4.2.1 Upland Vegetation and Horticultural Resources

The existing vegetation adjacent to the Pond will be impacted and some vegetation will be removed to accomplish the work of this project. In particular, every effort will be made to remove invasive vegetation such as Purple Loosestrife and Knotweed. The Heritage trees adjacent to the project areas will be protected to their drip line, pruned, and fertilized so impact to them should be minimal. Larger contiguous shoreline and vegetated areas will be entirely fenced from construction activity. Shoreline areas where the bank is to be regarded and the existing vegetation removed/replaced are shown in the Preliminary Design report in Appendix I.

The bank restoration and re-vegetation process will be staged such that the extent of bare ground will be minimized at any point in time. Silt fencing will be placed and maintained along all areas to be disturbed. As soon as bank re-grading work in an area is completed, the soil will be tilled and aerated and the area will either be sodded or mulched with pine bark in advance of the planting of vegetation. Sod will be pegged into the ground on slopes greater than 3:1. The wetland shelf will also be planted as soon after re-grading as possible.

The Daisy Field staging area will be approximately 45,000 sf. It will be used for 14 to 16 months, depending on the time of year it is to be closed and the next growing season. When a staging area is to be restored, the crushed stone base will be removed and the loam ground restored. The surrounding silt fencing, however, will remain until grass is growing. Only then will it be removed and the ground were the fence had been will be raked level and seeded. Seeding will be conducted by hydromulching. In the event that a staging area is to be closed outside of a growing season, the crushed stone base, site security and siltation fencing will remain in place until the next growing season. Complete site restoration will be conducted within the first two months of the growing season.

6.4.2.2 Aquatic and Wildlife Resources

Leverett Pond supports a warm water fishery, which includes bottom feeding species, pan fish, forage species and some predatory fish such as bass. Blue back herring may migrate through this river section. The existing benthic community (bottom inhabiting organisms) is pollution tolerant. The wildlife resources include urban species that are adapted to high levels of disturbance. The benthic resources will be the most severely impacted aquatic community from the dredging. There will be a near total loss of these species, which are dominated by pollution tolerant organisms. Recruitment will take a number of years because the upstream benthic pool will also be reduced. However, in weighing the negative and positive aspects of this loss, the value of the bottom food chain versus the planktonic food chain needs to be considered. Bottom feeding fish such as goldfish, suckers, and carp do not contribute in a positive manner to fish populations nor water quality. Studies have shown that bottom feeding fish substantially contribute to the murkiness of the water, nutrient levels, and algae growth by agitating the sediments, re-solubilizing nutrients into the water, promoting the growth of less desirable blue-green algae upon which zooplankton cannot feed, and damaging spawning nests of other fish. This results in negative water quality impacts that also produces a negative impact on the zooplankton and the food chain for pan fish and game fish. A fishery resource that is based on plankton for food is often considered to be more desirable than a dominating bottom food source. In fishery management, it is a common practice to reclaim water bodies of undesirable species including the bottom dwellers. Following fish reclamation, water clarity improves, nutrient concentrations are reduced, the growth of blue-green algae decreases, and an increase in the extent of spawning nests for pan fish and game fish increases. Under the present conditions in the Muddy River, the bottom dwelling fish resource is dominant, and is undesirable due to its adverse effect on water quality and magnification of contaminants in the food chain. The dredging will not result in a sterilization of bottom resources. Some benthic organisms will be 'kicked aside" by the turbulence of the dredging and remain to grow and reproduce. There will also be a continual recruitment of worms and midges from other upstream areas, including the unaffected portion of the "Babbling Brook", undredged parts of Wards Pond, Spring Pond, and storm drains that are not affected by the dredging operation.

Fish Resources

During dredging there will be some mortality of fish. The mortality may be proportionally higher in the bottom dwelling species such as carp and suckers than the open water species such as sunfish, bass, pickerel, etc. This impact is not considered adverse, however, because the water quality of the Muddy River would benefit from substantially fewer bottom dwelling species, which enhance the cycling of nutrient and contaminants to the water.

The removal of sediment from Leverett Pond will result in an enhanced aquatic habitat for fish resources. The removal of contaminated sediment will lead to improved dissolved oxygen and less nutrient and contaminant cycling from the sediments to the water. The removal of hydrocarbon compounds (DDT and PCBs) will also reduce the content of contaminants in edible fish tissue, thereby reducing bio-accumulation through the food chain. It is also anticipated that within a free flowing and deeper water column, combined with daylighted sections of the river, anadromous fish migration will increase.

Wildlife Resources

The positive long-term effects to wildlife resources in Leverett Pond will outweigh the temporary negative impacts. Minimal disturbance to avian species will likely occur during dredging and re-vegetation operations as the birds relocate to areas of less disturbance. The planting of larger areas of trees and shrubs may, however, attract greater numbers of birds after the construction has been completed. In locations where dredging occurs during winter hibernation, amphibian and reptile species will not be able to relocate the dredging and will be lost.

There will also be an active rodent control program (see Section 7.0 - Environmental Mitigation Plan) that is intended to control as much rodent displacement as possible during the dredging. There will also be a multi-faceted program for goose control. This is described in Section 8 - Management and Maintenance.

The re-vegetation of the land around Leverett Pond will result in a substantial increase of habitat diversity as the result of an improved composition of the aquatic, wetland, shrub and tree canopy components of the ecosystem. The proposed planting plan is shown in detail in the Preliminary Design Report contained in Appendix I. Figures 6-23 and 6-24, taken from the Preliminary Design Report, are illustrations of the typical plant massing that are proposed for Leverett Pond along Pond Avenue as well as the restoration of the Babbling Brook. The proposed shrub and tree species that are listed in Table 6-2 were selected from the original Olmsted design. Because the Muddy River was a tidal estuary when Olmsted prepared his design, it was necessary to select freshwater wetland plants that would grow in today's freshwater environment. The list includes 20 species of shrubs and trees from the original Olmsted planting list, six species of shoreline plants, and eleven species of emergent wetland plants. There is no plan to introduce submersed aquatic species because they will colonize the aquatic environment as seeds are introduced by waterfowl and upstream sources.

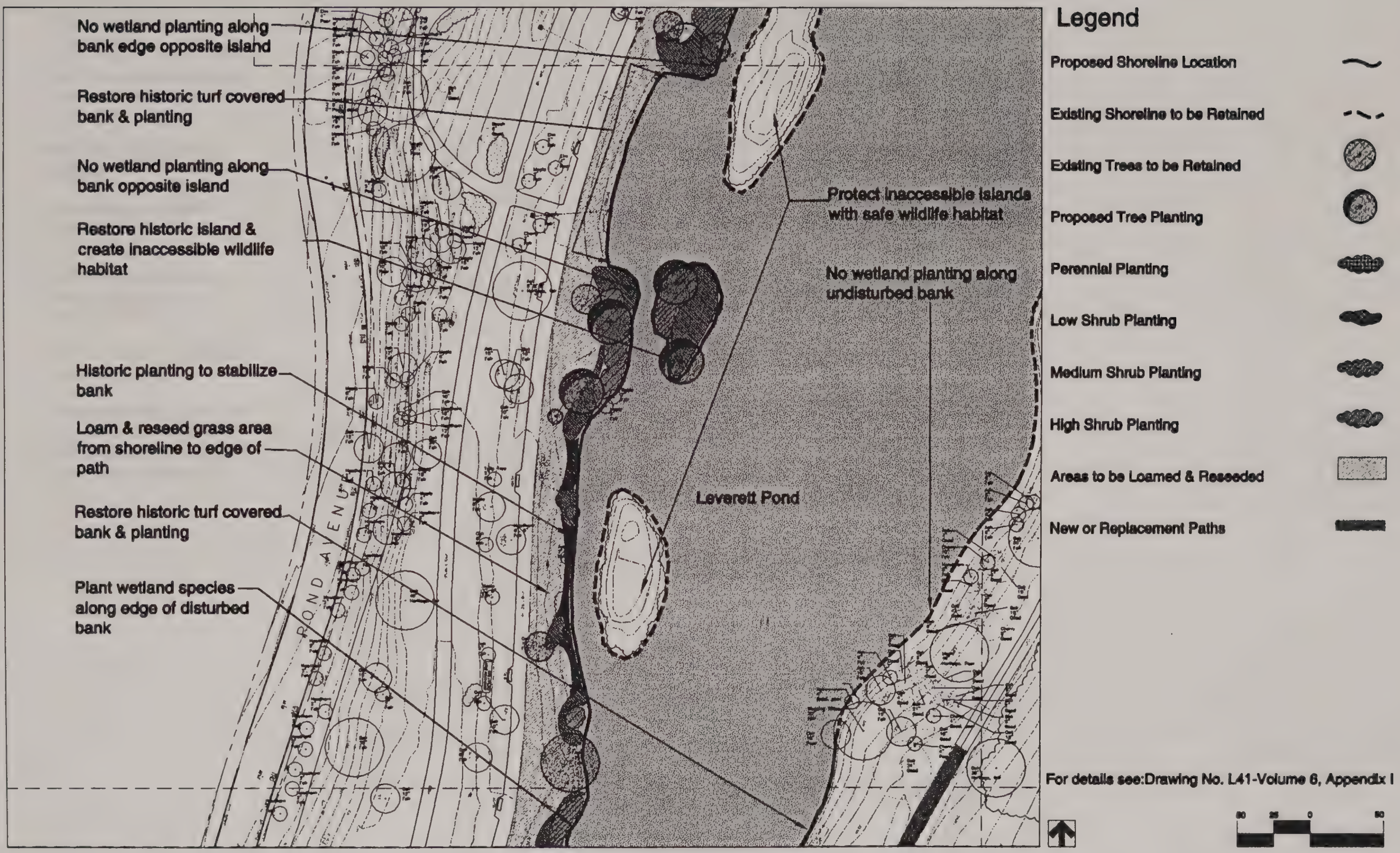
No wetland planting along bank edge opposite island
Restore historic turf covered bank & planting
No wetland planting along bank opposite island
Restore historic island & create inaccessible wildlife habitat
Historic planting to stabilize bank
Loam & reseed grass area from shoreline to edge of path
Restore historic turf covered bank & planting
Plant wetland species along edge of disturbed bank
Protect inaccessible islands with safe wildlife habitat
No wetland planting along undisturbed bank
Levrett Pond
POND AVENUE
Legend
Proposed Shoreline Location
Existing Shoreline to be Retained
Existing Trees to be Retained
Proposed Tree Planting
Perennial Planting
Low Shrub Planting
Medium Shrub Planting
High Shrub Planting
Areas to be Loamed & Reseeded
New or Replacement Paths
For details see:Drawing No. L41-Volume 6, Appendix I
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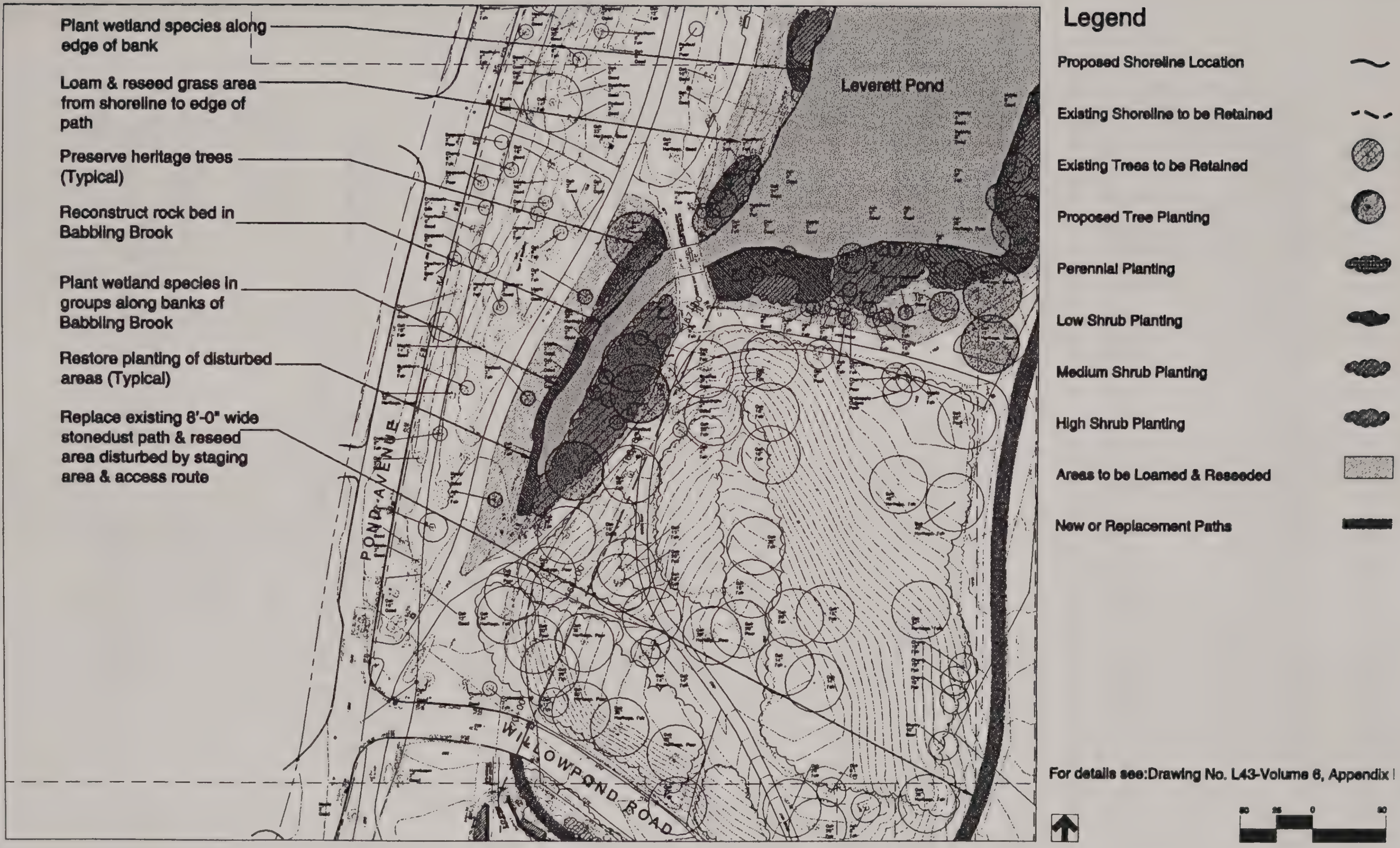
Figure 6-23
Typical Plant Massing Proposed for Levrett Pond, Pond Avenue Area
Source: Pressley, Inc.


Plant wetland species along edge of bank
Loam & reseed grass area from shoreline to edge of path
Preserve heritage trees (Typical)
Reconstruct rock bed in Babbling Brook
Plant wetland species in groups along banks of Babbling Brook
Restore planting of disturbed areas (Typical)
Replace existing 8'-0" wide stonedust path & reseed area disturbed by staging area & access route
Leverett Pond
POND AVENUE
WILLOWPOND ROAD
Legend
Proposed Shoreline Location
Existing Shoreline to be Retained
Existing Trees to be Retained
Proposed Tree Planting
Perennial Planting
Low Shrub Planting
Medium Shrub Planting
High Shrub Planting
Areas to be Loamed & Reseeded
New or Replacement Paths
50
25
0
50

For details see:Drawing No. L43-Volume 6, Appendix I

Figure 6-24
Typical Plant Massing Proposed for Leverett Pond, "Babbling Brook" Area
Source: Pressley, Inc.

The proposed work also includes the re-vegetation of the denuded island, the stabilization of eroding banks around the islands, and the protection of wildlife habitat on the three islands by the introduction of dense and humanly inaccessible plants.

6.4.2.3 Rare Species

Although the NHESP atlas indicated that grebes were present in Leverett Pond, an examination of Leverett Pond by NHESP staff resulted in the conclusion that grebe habitat is not present. Therefore, the Leverett Pond area does not contain any rare, threatened or endangered species.

6.4.2.4 Wetland Resources

The Brookline side of Leverett Pond contains some species of vegetation, including Purple Loosestrife, that are growing in a thin strand along the shoreline. Grass and trees are also prevalent along the paved walkway in Brookline. The Boston shoreline has shoreline vegetation of a somewhat greater depth with shrubs, trees and mowed grass. The bordering vegetated wetlands around Leverett Pond are limited to a thin strand along the shoreline.

The proposed work around Leverett Pond includes the hand removal of purple loosestrife and the introduction of the plant species that are listed in Table 6-2. This will result in the increase in the diversity of wetland and upland vegetation. Where one or two species exist presently, they will be replaced by six species of shoreline plants, and eleven species of emergent plants. This will result in a substantial enhancement of the functions and values of the aquatic, wetlands, and upland ecosystems as well as a commensurate enhancement in wildlife functions and values.

Table 6-10 contains a comparison of the present and future extent of the wetland resource areas. In accordance with the Wetland Protection Act, slightly more than half of the bank and bordering vegetation wetland would be altered in the process of restoration to future conditions.

Table 6-10

A Comparison of the Present and Proposed Future Extent of Resource Areas in Leverett Pond as Defined in 310 CMR 10.00

Resource Area	Present	Future
Bank	4,540 lf	4,540 lf
Land Under Water	9.9 acres	9.9 acres
Bordering Vegetated Wetland	0.2 acres	0.3 acres
Bordering Land Subject To Flooding	Not Determined	No Change
Riverfront Area	Not Determined	No Change

6.4.2.5 Ecological Functions and Values

The proposed dredging activities in Leverett Pond are described in Section 5.5.2.2. The dredging will deepen the pond providing a more suitable fish habitat (i.e., cooler temperatures, improved oxygenation). After dredging activities are completed, invasive species such as purple loosestrife (*Lythrum salicaria),* japanese knotweed (*Polygonum cuspidatum*), common reed (*Phragmites australis*), and buckthorn (*Rhamnus sp.*), will be removed. The method of vegetation removal is also described in Section 5. The area will be replanted with a mixture of historical wetland and upland vegetation as listed in Table 6-2. Landscaping plans are provided in Appendix I. In addition, six historic turf covered banks will be restored and one of the three existing islands will be re-shaped and re-vegetated to provide better wildlife habitat. In addition, the eroding banks around the islands will be stabilized and the wildlife habitat on the three islands will be protected by the introduction of dense and humanly inaccessible plants. These measures will serve to increase the ecological functions and values..

The removal of nuisance aquatic vegetation along the bank and in the bordering vegetated wetlands (BVW) will benefit wildlife and provide soil and sediment control. The replacement vegetation will benefit waterfowl and avian species as a source of food and cover. In addition, much of the emergent vegetation will provide nesting areas for fish species. The selected emergent species' extensive root systems will help stabilize soil, thereby preventing erosion and further siltation.

Much of Leverett Pond has manicured lawn at the edge of water. Pedestrian activity and flow rates have caused substantial portions the bank to erode. Emergent vegetation will discourage the public from trampling these area and retard water velocity, helping to stabilize the bank. Examples of such emergent species include sweet flag (*Acorus calamus*) and bur-reed (*Sparganium eurcarpum*). Emergent vegetation will be planted 12 inches on center.

Similar to work to be conducted in Land Under Water (LUW), invasive vegetation will be removed from the bank and BVW areas. Species such as purple loosestrife (*Lythrum salicaria), Phragmites australis, Rhamus catharica* and *R. frangula* (common and European buckthorn,) will also be removed. Buckthorns are listed as invasive plants in Massachusetts. Buckthorns rapidly invade areas and out-compete native species which provide more diverse habitats to a greater variety of species.

Banks and upland areas will be replanted with a mixture of historic wetland and upland plantings. Low shrubs such as *Xanthorhiza simplicissima* and *Rhus aromatica* will be planted 18 inches on center.

Wetland functions and values under proposed conditions were evaluated using the same methodology that was used to assess the existing conditions (see Section 4.5.2.5). The purpose of the Functions and Values Evaluation was to determine, in a non-biased manner, any ecological benefits that resulted from the proposed enhancement of the wetland, shoreline, and upland vegetation. The significance of the information in Table 6-11 is in the results of a comparison between the existing conditions (see Section 4.5.2.4 - Wetland Resources) and the proposed conditions. For Leverett Pond and its surrounding area, there will be an overall increase in the ecological functions and values of flood flow alteration, fish habitat, sediment/toxicant retention, nutrient removal, product export, sediment/shoreline stabilization, wildlife habitat, and recreation.

6.4.3 Cultural Environment

6.4.3.1 Historic Resources

The Cove footbridge and the footbridge at the southern end of the Pond are extant features from the Primary Period of Significance. These structures and other historic features that comprise the character of the parkland will be protected so impact to them will be minimal. Limitations in specifications will also be provided for these bridges so as not to disturb footing structures.

The location of the path system surrounding the pond retains integrity to the Primary Period, but is rolled stone on bituminous on the Brookline side and stone dust on the Boston side. The original paths were stonedust. A portion of the historic path on the Boston side near Boylston Street and The Riverway, which allowed access to one of the original Olmsted beaches, has been lost over time. This path will be restored when the shoreline and beach are restored under this contract. The use of the path systems will be restricted at different times during construction so movement within and across the park will be signed to control, direct, and protect pedestrian access during construction. Temporary paths will be provided as necessary.

Since the Primary Period of Significance, the shoreline has been modified by placement of gabions and the creation of the third island on the Brookline or West Side. The dredging operations and stabilization of the banks planned under this construction project will both impact the shoreline. Removal of invasive species and planting of new wetland species and bank plantings to prevent erosion and control access of geese to the denuded lawn areas will impact the shoreline. Since access of dredging equipment to the water will be limited, the only areas that will be impacted by dredging equipment entering and exiting the water will be these selected points of entry. All dredging operations will be conducted from the water. Invasive species will be removed from access points on the land side. Areas that may be compacted by these operations will be aerated and restored upon completion of dredging and shoreline restoration.

The existing vegetation, except for heritage trees, has limited historical integrity for the Primary Period of Significance. The heritage trees will be protected, pruned, and fertilized so impact to them should be minimal. Upland vegetation that has been planted under recent projects and trees and shrubs that are adjacent to the work will be protected so impact on them should be minimal. During construction, historic structures and vegetation to be protected will be enclosed with chain link protection

Leverett Pond - FUTURE

Wetland Function-Value Evaluation Form

Total area of wetland_______Human made?____Is wetland part of a wildlife corridor? __________or a "habitat island"?

Adjacent land use____Recreation____________ Distance to nearest roadway or other development________________

Dominant wetland systems present Scrub Shrub/Emergent Contiguous underdeveloped buffer zone

present__No________

Is the wetland a separate hydraulic system?_No__________If not, where does the wetland lie in the drainage basin?______

How many tributaries contribute to the wetland?_1________Wildlife & vegetation diversity/abundance (see attached list)

Wetland I.D.
Latitude______Longitude________
Prepared by:________Date________
Wetland Impact:
Type______________Area________
Evaluation based on:
Office_____________Field______
Corps manual wetland delineation
completed? Yes______No________

Function/Value	Occurrence Y	Occurrence N	Rationale (Reference #)*	Principal Function(s)/Value(s)	Comments
Groundwater Recharge/Discharge		X	8, 13		No evidence of groundwater recharge or discharge.
Floodflow Alteration	X		3, 4, 5, 12,		Wetland is not large enough to hold significant amounts of flood waters.
Fish and Shellfish Habitat	X		3, 4, 7, 8, 10, 12, 14, 17.	X	Fish are present in the pond.
Sediment/Toxicant Retention	X		1,2, 3*,5,15,16*		Wetlands are narrow add provide no sediment retention.
Nutrient Removal	X		2,3*, 4, 6,8* 9,11*12*		Wetlands are narrow add provide no nutrient retention.
Production Export	X		1, 2, 4, 6, 7*8,12		Wetlands contain little wildlife food value.
Sediment/Shoreline Stabilization	X		1, 3, 5, 9, 15	X	Vegetation along the bank has provided stabilization in most areas.
Wildlife Habitat	X		2, 7, 8, 9, 14	X	Wetland is not buffered, and there is little habitat diversity in vegetation. Wetland does provide habitat to ducks.
Recreation	X		1, 4, 7, 10, 11, 12	X	Wetland is easily accessible, and has some potential to function as educational and recreational area.

Table 6-11
Wetland Function-Value Evaluation Form for Leverett Pond

Function/Value	Occurrence Y	Occurrence N	Rationale (Reference #)*	Principal Function(s)/Value(s)	Comments
Educational Scientific Value		X	3, 8, 9, 10, 12, 13,		Wetland is easily accessible, and has some potential to function as educational and recreational area.
Uniqueness/Heritage		X	1, 3, 8, 9, 10, 14, 16		
Visual Quality/Aesthetics		X	2, 7		Direct view of wetland and open water exist from the roadway.
ES Endangered Species Habitat		X			No endangered species have been found in a portion of this pond
Other					

*Refer to back up list of numbered considerations.

Notes: *=Restoration goals are designed to provide and enhance these functions and values.

The 13 functions and values that are considered by the Regulatory Division for any Section 404 wetland permit are listed below. The list includes eight functions and five values. Values are grouped together at the end of the list.

These are not necessarily the only wetland functions and values possible. Not are they so precisely defined as to be unalterable. However, they do represent the best working 'palette' of descriptors, which can be used to paint an objective representation of the wetland resources associated with a proposed project.

Groundwater Recharge/Discharge--This function considers the potential for a wetland to serve as a groundwater recharge and/or discharge area. Recharge should relate to the potential for the wetland to contribute water to an aquifer. Discharge should relate to the potential for the wetland to serve as an area where groundwater can be discharged to the surface.

Floodflow Alteration (Storage & Desynchronization)--This function considers the effectiveness of the wetland in reducing flood damage by attenuation of floodwaters for prolonged periods following precipitation events.

Fish and Shellfish Habitat--This function considers the effectiveness of seasonal or permanent waterbodies associated with the wetland in question for fish and shellfish habitat.

Sediment/Toxicant/Pathogen Retention--This function reduces or prevents degradation of water quality. It relates to the effectiveness of the wetland as a trap for sediments, toxicants or pathogens.

Nutrient Removal/Retention/Transformation--This function relates to the effectiveness of the wetland to prevent adverse effects of excess nutrients entering aquifers or surface waters such as ponds, lakes, streams, rivers, or estuaries.

Product Export (Nutrient)--This function relates to the effectiveness of the wetland to produce food or usable products for human, or other living organisms.

Sediment/Shoreline Stabilization--This function relates to the effectiveness of the wetland to stabilize stream banks and shorelines against erosion.

Wildlife Habitat--This function relates to the effectiveness of the wetland to provide habitat for various types and populations of animals typically associated with wetlands and the wetland edge. Both resident and/or migrating species must be considered. Species lists of observed and potential animals should be included in the wetland assessment report.

Recreation (Consumptive and Non-Consumptive)--This value considers the effectiveness of the wetland and associated watercourses to provide recreational opportunities such as canoeing, boating, fishing, hunting and other active or passive recreational activities.

Consumptive opportunities consume or diminish the plants, animals, or other resources that are intrinsic to the wetland, whereas non-consumptive opportunities do not.

Education/Scientific Value--This value considers the effectiveness of the wetland as a site for an 'outdoor classroom' or as a location for scientific research or study.

★ **Uniqueness/Heritage**--This value considers the effectiveness of the wetland or its associated waterbodies to produce certain special values. Special values may include such things as archeological sites, unusual aesthetic quality, historical events, or unique plants, animals, or geological features.

Visual Quality/Aesthetics--This value relates to the visual and aesthetic qualities of the wetland.

ES **Threatened or Endangered Species Habitat**---This value considers the effectiveness of the wetland or its associated waterbodies to support threatened or endangered species.
Source: ACOE

fencing, which will remain in place until final completion of all proposed adjacent work and then the protected areas will be restored in kind as required.

6.4.3.2 Land Use

The presence of a staging area in Daisy Field will result in a temporary disturbance to the use of the ball field while the new diamond is relocated after use of the staging area. There will not be any long-term impact to the use of Leverett Pond nor its surrounding parkland. The current land uses surrounding the site will not be affected by the work of this project.

6.4.3.3 Recreation

Recreation in this area historically and currently has been both active (baseball, walking, biking, jogging) and passive. Treatment of this area under this project will retain the current active and passive recreation uses when the project is complete. The use of some active and passive areas will be restricted at different times during construction so entrance and egress to the area will be signed to control, direct, and protect pedestrian access during construction. The northerly softball field that is the one closest to the water, will be closed while being used as part of the staging area. The southerly little league field will be fenced off from the staging area and kept in operation during construction.

As shown in Appendix I - Preliminary Design Report, the northerly field will be re-oriented away from Leverett Pond and rebuilt after construction is complete. The existing skin infield is a soil mix within the base lines and covering the entire infield. The re-oriented field will be rebuilt with a grass infield (except for basepaths and pitcher's mound) to reduce sediment runoff problems that currently exist. The historic view of Leverett Pond will be restored because the backstop will no longer be at the Pond. The existing pathways will be maintained in operation throughout construction. The view across the outfield grass once the re-orientation is complete will be more in line with the historic view of a grassed meadow.

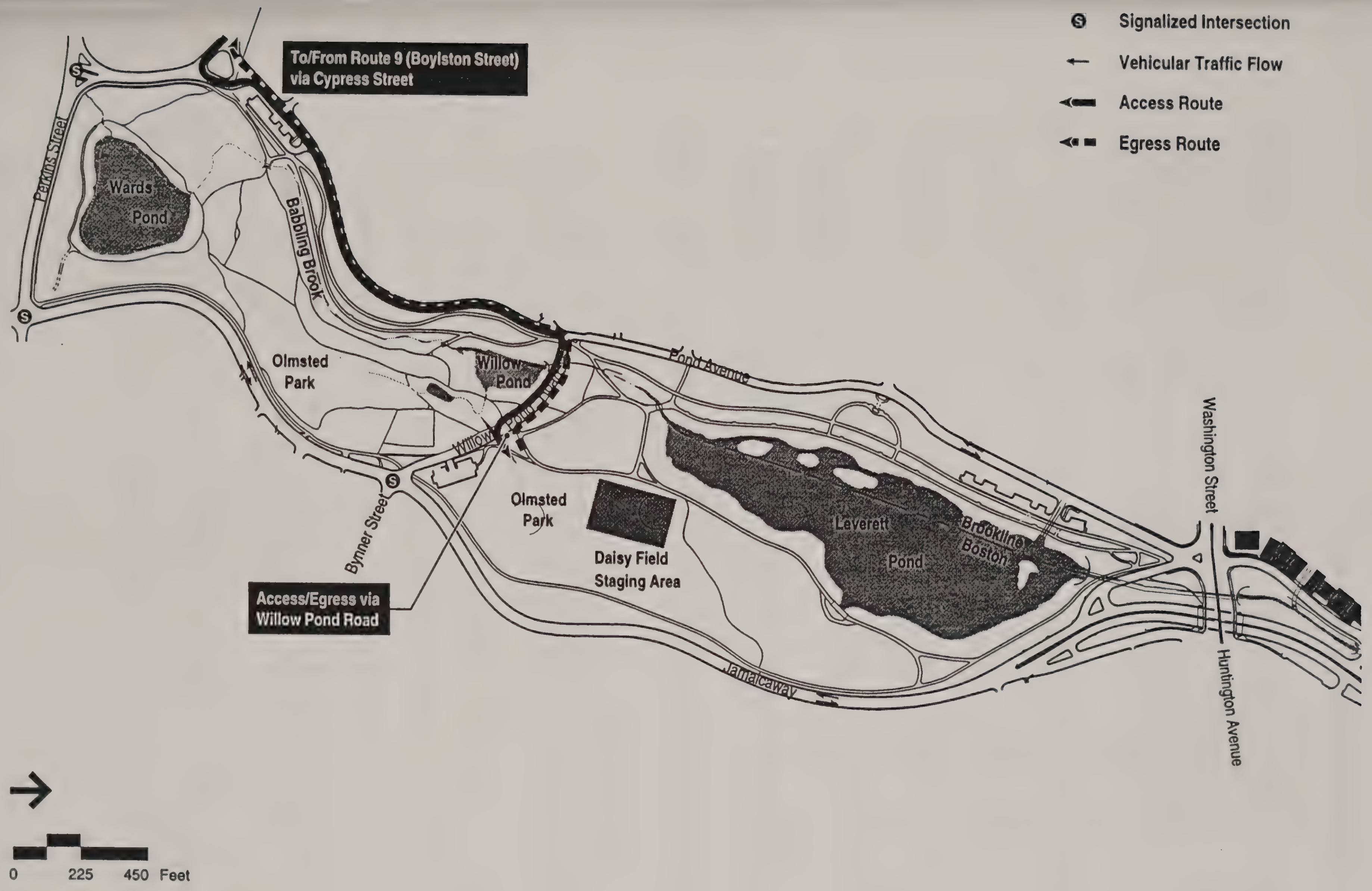
Temporary pedestrian path detours will be mentioned around construction area. Access to the staging area will be provided along the current path.

6.4.3.4 Pedestrian Access

As indicated on Figure 6-23, there are no planned temporary sidewalk or path closures in the Leverett Pond area. It should be noted that Willow Pond Road does not provide sidewalks or paths adjacent to the travelway even through there are pedestrian demands along Willow Pond Road. In the evening peak hour, approximately 40 pedestrians used Willow Pond Road. The project does not negatively impact these relatively low pedestrian demands along Willow Pond Road.

6.4.4 Traffic

Section 6.1.4 documents the traffic that is expected to be generated by the staging areas. As Figure 6-25 indicates, the truck traffic to/from the Daisy Field Staging Area



CDM Camp Dresser & McKee Inc.

Figure 6-25
Leverett/Willow/Wards Pond Area
Potential Staging Area
Access/Egress Plan

Source: VHB, Inc.

is proposed to be routed along Pond Avenue to Cypress Street to Route 9. This truck routing avoids several congested intersections along The Jamaicaway at Perkins Street. The expected project impacts to traffic operations along Pond Avenue and Cypress Street are minimal. There will be an increase in truck traffic along these roads. However, the periods of truck traffic activity will not coincide with peak traffic conditions in the area, resulting in no negative impact to traffic operations during peak periods.

6.5 Assessment of Environmental Impacts at Willow Pond

Construction activities that are proposed within the Willow Pond area include:

- The improvement of the flood storage capacity by the dredging and removal of approximately 6,000 cubic yards (cy) of accumulated sediment,
- The preservation of the historic park shoreline through the restoration of the bank to its historic intent,
- The restoration of the historic Island and planting of vegetation from the Olmsted planting list,
- The restoration of the historic island in the Babbling Brook upstream of Willow Pond
- The preservation of the historic park features via the re-vegetation of the new bank, the re-introduction of an island, and the establishment of wetland areas and the restoration of terrestrial habitat with indigenous plantings, Enhancement of the habitat of the three-spine stickleback,
- The restoration of the terrestrial habitat with indigenous plantings,
- The repair of the rock dam between Spring Pond and Willow Pond,
- The repair or replacement of worn pathways and denuded ground.

The proposed construction and re-vegetation activities are discussed in Section 5.0 - A Description of the Project's Design and Construction. The details are shown in the Preliminary Design Report provided in Appendix I.

The types of impacts that have been analyzed include those to the physical (hydrology, sediment, site access, etc) , chemical (water quality), biological (benthic macroinvertabrates, insects, fish, bird, vegetation, etc.), and human (pedestrian movement, traffic, site access, park use, etc.) environmental elements.

6.5.1 Physical Environmental Features

A consistent goal of the Muddy River Project is to provide as much ecosystem enhancement as possible. At Willow Pond, the proposed work includes the repair of the stone dam between Spring Pond and Willow Pond, the enhancement of the habitat through the planting of diverse species of wetland, shoreline and upland Olmsted shrubs and trees, the reintroduction of a small island, and the establishment of BMP's to improve water quality. The physical environmental features around Willow Pond will be temporarily altered during construction. Long-term physical alterations are related to bank stabilization, deepening of the water body, reconstruction of an island, and the enhancement of the aquatic and upland ecosystems to more natural ecosystems.

The Daisy Field staging area (see Figure 6-22) will be used for the dredging of Willow Pond. A 6-8 inch pipeline will be placed between the two locations through which the dredged materials will be pumped. The dredge will be lifted into the pond with a crane from an appropriate location on the bank. Therefore, the disturbance of the physical environment at Willow Pond will be temporary.

There will also be extensive temporary piping for the hydraulic dredging will be placed between Willow Pond and Daisy Field staging area. The piping will be placed in a manner that does not intrude with pedestrians using the paths. When paths and roadways need to be crossed, the pipes will be placed in shallow trenches and covered with asphalt/stone dust. However, in order to minimize the amount of traffic disturbance, the pipes will be laid through the existing culverts and bridges whenever possible.

6.5.1.1 Hydrology

The hydraulic capacity of Willow Pond is discussed in Section 4.6.1.1. Willow Pond does not have a direct impact on the exacerbation of downstream flooding. However, with the restoration of the functioning outlets on the dam, it will be possible to provide a small volume of floodwater storage. If the pond water level is maintained below the crest by use of the dry weather outlet (see Figure 4-48-Willow Pond Outlet).

The restoration project has been designed to prevent an interruption of water flow into or from Willow Pond during construction.

6.5.1.2 Sediment Quality

Sediment that has accumulated in Willow Pond, and which will be removed (approximately 5,900 cy), consists of a soft black organic silt layer that is intermixed with fine to coarse sand and gravel of a depth of up to eight feet. The native underlying material consists of sand and silt. The sediments have been found to contain polynuclear aromatic hydrocarbon (PAHs) compounds, volatile organic compounds (VOCs), and metals (see Appendix F - Sediment Characterization). Fuel oil has been introduced to the pond via the Chestnut Street drain. Sediment samples exhibit elevated concentrations of PAHs, the depth of contamination could not be determined since only the top two feet of fill material was sampled. The elevated levels of phosphorus in the fill sediment could be the result of particulate bound or dissolved phosphorus introduced via runoff and/or stormwater discharges containing animal and waterfowl fecal matter or from point source discharges in the area. Sample locations were only accessible by foot and the sediment layer was too soft to support the tripod sampling equipment set-up. This accumulated sediment will be removed to a depth of seven feet.

The dredging of Willow Pond will have a positive impact on water quality due to the reduction in the cycling of nutrients and other contaminants and the reduction of petroleum contamination.

6.5.1.3 Water Quality

Willow and Wards Pond are the only two water bodies within the project limits where natural water flow may be greater than stormwater flow. Willow Pond receives clear, cold water from Spring Pond and clear warmer water from Wards Pond. The latter water source is warmer and of low nutrient content since the water originates from Jamaica Pond. The Chestnut Street Drain provides drainage for 179 acres and discharges into the head-end (southern) of Willow Pond. The Chestnut Street Drain is believed to be the source of the majority of the sediment in Willow Pond. Leaking from upstream underground fuel storage tanks via the Chestnut Street Drain also contributes to the petroleum hydrocarbons and volatile organic compounds that are found in the sediments. Appendix G contains water quality data.

Long-term and short-term impacts to water quality will occur during the life of the Muddy River Project. The short-term negative impacts to water quality in Leverett Pond will be mitigated to a large extent by construction mitigation measures that are described in Section 7.0

The restoration and enhancement of Willow Pond will produce substantial long-term benefits. These include:

- The removal of the sediment will increase the flood flow capacity of the River,
- The removal of the contaminated sediment will enhance the quality of the bottom of Willow Pond for colonization by benthic organisms,
- The volume of the aquatic habitat will be substantially increased,
- The spawning habitat for fish will be improved,
- The habitat for the rare species of fish - the three-spine stickleback, will be improved,

- The overall quality of the aquatic/riparian/upland habitat and its diversity will also be substantially improved.

During the dredging and reconstruction activities at Willow Pond, there will be turbid water that results from the dredging, as well as from the island reconstruction and the repairs to the dam for Spring Pond. The re-grading of the unpaved pathway system could also be a limited source of suspended solids during the early stages of reconstruction. There will not be any return water from the dewatering process discharged to Willow Pond. The dewatering of material that is dredged from will pond will take place at the Daisy Field staging area were the return water will be discharged to Leverett Pond. Due to the small size of Willow Pond, it would not be practical to have water quality limits on suspended solids that originate from the dredging. Rather, it is proposed that there be a suspended solids limitation in Leverett Pond of 200% above background concentrations at a distance of 200 feet from discharge of the babbling Brook into Leverett Pond.

Because Spring Pond contains a threatened fish species, the three-spine stickleback, other than the mitigation measures that are disguised in Section 7- Environmental Mitigation, there will not be any construction work that could directly affect Spring Pond. This includes surface runoff from the grassed-over former MDC Kelley ice skating rink.

Prior to the final approval by the Department of Environmental Protection (DEP) and the Boston and Brookline Conservation Commissions, the Contractor will be required to submit a Stormwater/Dewatering Pollution Prevention Plan (S/DPPP) for review and approval. The S/DPPP will contain an Erosion and Sedimentation Control Plan and a Spill Prevention Control and Countermeasure Plan (see Section 7.0 - Environmental Mitigation Plan). These Plans will state the Contractor's intent for managing site runoff, monitoring, and maintenance.

The removal of contaminated sediment will improve water quality by deepening the Pond, reducing sediment oxygen demand, and increasing dissolved oxygen that, in turn, reduces nutrient and contaminant cycling from the sediments to the water. In addition, the water quality of Willow Pond will be improved in the long-term through the re-construction/modification of a sediment particle separator(s) on the Chestnut Street Drain, and other BMP's (see Section 5.9 - Best Management Practices). Willow Pond is also included in a long-term water quality monitoring program (see Section 7.0 - Environmental Mitigation Plan).

6.5.2 Biological Environment

The proposed Muddy River Project will result in the ultimate enhancement of the biological environment. This work includes the upland vegetation, wetlands, and aquatic and wildlife resources. However, in the course of conducting the dredging, construction and restoration work, temporary disturbances to the biological resources will result. The short-term and long-term impacts to the biological resources are included in the following sections.

6.5.2.1 Upland Vegetation and Horticultural Resources

The existing vegetation adjacent to the river and in the staging areas will be impacted and vegetation will be removed to accomplish the work of this project. In particular, every effort will be made to remove invasive vegetation such as glossy buckthorn and Knotweed. The shoreline around Willow Pond will be regraded and re-vegetated. These areas are shown in the Preliminary Design Report in Appendix I. The upland vegetation including staging areas adjacent to the project areas of impact will be protected, pruned, and fertilized so impact to them should be minimal. Adjacent larger contiguous areas may be fenced if construction is expected to impact these areas, otherwise they will be noted as outside of work limits to the Contractor. Restoration of the historic island that was upstream of Willow Pond will add to the ecotone and diversity of terrestrial and aquatic resources. The island will be vegetated with low shrubs as will the surrounding banks.

The bank restoration and re-vegetation will be staged such that the extent of bare ground will be minimized at any point in time. Silt fencing will be places and maintained along all areas to be disturbed. As soon as bank re-grading work in an area is completed, the soil will be tilled and aerated and the area will either be sodded or mulched with pine bark in advance of the planting of vegetation. Sod will be pegged into the ground on slopes greater than 3:1. The wetland shelf will also be planted as soon after re- grading as possible.

When a disturbed area is to be restored, the surrounding silt fencing will remain until grass is growing. Only then will it be removed and the ground where the fence had been will be raked level and seeded. Seeding will be conducted by hydromulching. Completed site restoration will be conducted within the first two months of the growing season.

6.5.2.2 Aquatic and Wildlife Resources

The existing aquatic and wildlife resources in Willow Pond area are limited. Willow Pond supports a warm water fishery that includes bottom-feeding species, pan fish, forage species and some predatory fish such as bass. Native flora and fauna, which constitute the natural resources of Willow Pond, show far more diversity because of the protected setting than the resources found further downstream. See Section 4 for existing resources.

Benthic Resources

The benthic resources will be the most severely impacted aquatic community from the dredging. There will be a near total loss of these species. Reintroduction of these species will take several years because the upstream benthic pool will also be reduced. However, in weighing the negative and positive aspects of this loss, the value of the bottom food chain versus the planktonic food chain needs to be considered. Bottom feeding fish such as goldfish, suckers, and carp do not contribute in a positive manner to fish populations nor water quality. Bottom feeding fish substantially contribute to the murkiness of the water, nutrient levels, and algae growth by agitating the sediments, re-solubilizing nutrients into the water, promoting the growth of less desirable blue-green algae upon which zooplankton cannot feed, and damaging spawning nests of other fish. This results in negative water quality impacts that also produces a negative impact on the zooplankton and the food chain for pan fish and game fish. A fishery resource that is based on plankton for food is often considered to be more desirable than a dominating bottom food source.

In fishery management, it is a common practice to reclaim water bodies of undesirable species including the bottom dwellers. Following fish reclamation, water clarity improves, nutrient concentrations are reduced, the growth of blue-green algae decreases, and an increase in the extent of spawning nests for pan fish and game fish increases. Under the present conditions in the Muddy River, the bottom dwelling fish resource is dominant, and is undesirable due to its adverse effect on water quality and magnification of contaminants in the food chain. However, dredging will not result in a sterilization of bottom resources. Some benthic organisms will be 'kicked aside" by the turbulence of the dredging and remain to grow and reproduce. There will also be a continual recruitment of worms and midges from other upstream areas, including the unaffected portion of the "Babbling Brook", undredged parts of Wards Pond, Spring Pond, and storm drains that are not affected by the dredging operation.

The restoration of the historic island that was upstream of Willow Pond will add to the benthic resources of the Babbling Brook. Some sections of the Babbling Brook have a rocky riffle bottom that is known to be populated with caddisflies and other suitable aquatic invertebrates. As the island is restored, the brook will be widened and rocks will be placed on the bottom to enhance he diversity of the benthic habitat and resource populations.

Fish Resources

During dredging some fish will be lost. The mortality rate may be proportionally higher for any bottom dwelling species (suckers, carp) than the open water species(sunfish, pickerel). This impact is not considered adverse, however, because the water quality Willow Pond would benefit from substantially fewer bottom dwelling species that enhance the cycling of nutrients and contaminants to the water. In addition, because the water level in Willow Pond often drops to nearly dry conditions, with only small channels for the water entering from Wards Pond and Spring Pond, the extent of fish in Willow Pond is limited. Dredging of approximately six feet from Willow Pond will provide for a permanent pool of water and greater fish habitat than presently exists.

Three-spine stickleback, a rare fish species, have been found in a very small pool (approximately 18 square feet) in Willow Pond where the water from Spring Pond falls below a small stone dam and forms the pool in Willow Pond. Watercress is also found in this pool and provides shelter for the fish. As and environmental mitigation measure, it is proposed that the sticklebacks in this pool be relocated to Spring Pond, the sediment in the pool be removed, the pool then be reconstructed with clean fill after the stone dam has been repaired, and the pool be re-vegetated. The sticklebacks could then re-inhabit the pool over time. Further details on the enhancement of habitat for the three-spine stickleback is provided in Section 7.2.

The removal of sediment from Willow Pond will result in an enhanced aquatic habitat for fish resources. The removal of contaminated sediment will lead to improved dissolved oxygen and less nutrient and contaminant cycling from the sediments to the water. The removal of organic sediments that with their present texture are not conducive for spawning of the common pan and game fish species, will result in the exposure of granular sediments on which these fish can spawn.

Wildlife Resources

The positive long-term impacts to wildlife resources in Willow Pond and its surrounding area will outweigh the negative effects. A minimal disturbance to avian existing species may be present during dredging and re-vegetation as the birds relocate to areas of less disturbance. The planting of larger areas of trees and shrubs will attract greater numbers of birds after the construction has been completed. In locations where dredging takes place during winter hibernation, amphibian and reptile species will not be able to escape the dredging and will die. During the summer, there will be less mortality as these species will be able to move from the dredging. However, the extent of reptile and amphibian species in Willow Pond is limited due to the often nearly dry conditions in the Pond during the summer. The dredging process is not perfectly complete and sufficient sediment will remain to accommodate some displaced amphibians and reptiles.

The re-vegetation of the land around Willow Pond will result in a substantial increase of habitat diversity as the result of an improved composition of the aquatic, wetland, shrub and tree canopy components of the ecosystem. The proposed planting plan is shown in detail in the Preliminary Design Report contained in Appendix I. Figure 6-26, taken from the Preliminary Design Report, is an illustration of the typical plant massing that is proposed for Willow Pond. The proposed shrub and tree species that are listed in Table 6-2 were selected from the original Olmsted design. Because the Muddy River was a tidal estuary when Olmsted prepared his design, it was necessary to select freshwater wetland plants that would grow in today's freshwater environment. The list includes 20 species of shrubs and tress from the original Olmsted planting list, six species of shoreline plants, and eleven species of emergent wetland plants. There is no plan to introduce submersed aquatic species because they will colonize the aquatic environment as seeds are introduced by waterfowl and upstream sources.

There will also be an active rodent control program (see Section 7.0 - Environmental Mitigation Plan) that is intended to control as much rodent displacement to adjacent areas as possible during the construction. In order that the goose problem that exists at Leverett Pond does not become relocated to Willow Pond, there will be a multi-faceted program for goose control. This is described in Section 8 - Management and Maintenance.

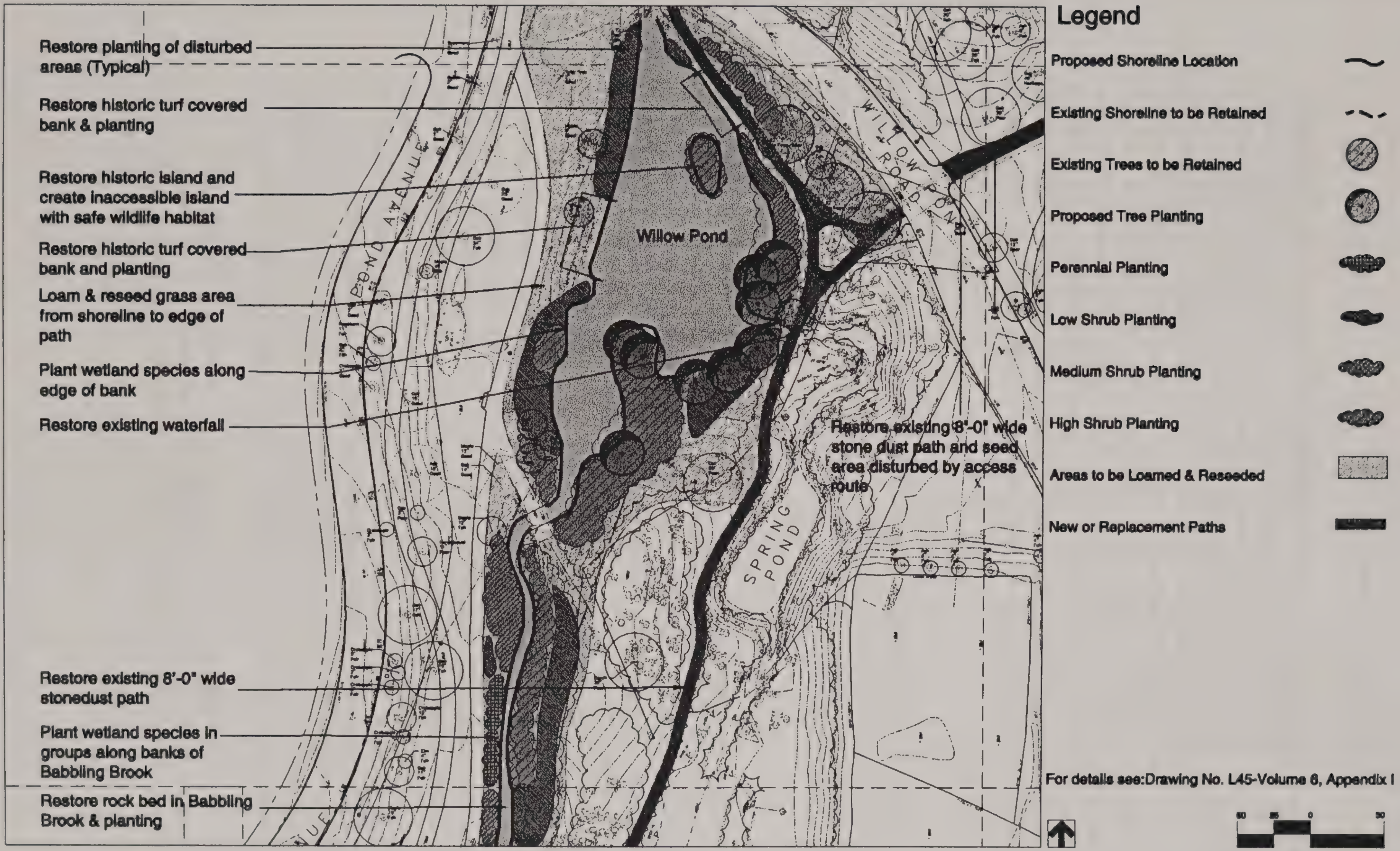

Restore planting of disturbed areas (Typical)
Restore historic turf covered bank & planting
Restore historic island and create inaccessible island with safe wildlife habitat
Restore historic turf covered bank and planting
Loam & reseed grass area from shoreline to edge of path
Plant wetland species along edge of bank
Restore existing waterfall
Restore existing 8'-0" wide stonedust path
Plant wetland species in groups along banks of Babbling Brook
Restore rock bed in Babbling Brook & planting
Willow Pond
WILLOW POND ROAD
POND AVENUE
SPRING POND
Restore existing 8'-0" wide stone dust path and seed area disturbed by access route
Legend
Proposed Shoreline Location
Existing Shoreline to be Retained
Existing Trees to be Retained
Proposed Tree Planting
Perennial Planting
Low Shrub Planting
Medium Shrub Planting
High Shrub Planting
Areas to be Loamed & Reseeded
New or Replacement Paths
For details see:Drawing No. L45-Volume 6, Appendix I
50
25
0
50

Figure 6-26
Typical Plant Massing Proposed for Willow Pond
Source: Pressley, Inc.

The habitat in those areas where the removal of invasive vegetation is proposed, will be restored with an indigenous plant community. The primary goal of this restoration process is to create a healthy ecosystem containing a variety of plant communities (i.e., diversity) ultimately resulting in the development of significant and valuable structural heterogeneity. This diverse habitat is preferred by a wide-variety of avian, mammalian and invertebrate species. Wading birds such as great blue heron, green heron and black-crowned night heron will take advantage of bank habitat. The interface or edge effect between terrestrial and aquatic environments (the ecotone) provides significant food sources, shelter, breeding and nesting areas for a variety of invertebrates including dragonflies, butterflies and beetles, which in turn provide food sources for all growth levels (larval, pupa and adult) for avian and small mammal species.

6.5.2.3 Rare Species

The Willow Pond area contains a rare fish species, the three-spine stickleback (*Gasterosteus aculeatus*). The stickleback is principally located in Spring Pond, which is a tributary to Willow Pond (see Section 4.6.2.3). The stickleback is also found in a small pool below the dam on Spring Pond.

6.5.2.4 Wetland Resources

The sides of Willow Pond are steep and vegetated with a bordering vegetated wetland resource area. On the Brookline side there are some species of wetland vegetation, including Purple Loosestrife, which are growing along the shoreline. Grass and trees are also prevalent along the paved walkway in Brookline. The Boston shoreline is vegetated with wetland plants, shrubs, and trees. The bordering vegetated wetlands around Willow Pond are limited to a thin strand along the shoreline. *Phragmites* is not present at Willow Pond although glossy buckthorn and Japanese knotweed, both invasive species, are growing along the shoreline. The proposed work around Willow Pond includes the removal of the buckthorn, knotweed, and purple loosestrife followed by the introduction of the plant species that are listed in Table 6-2. As also illustrated in Figure 6-26, the historic island will be reconstructed in Willow Pond and vegetated with wetland plants and shrubs from Table 6-2. All of this restoration will result in an increase in the diversity of wetland and upland vegetation. Where few species exist presently, they will be replaced by more species of shoreline plants and emergent plants. This will result in a substantial enhancement of the functions and values of the aquatic, wetlands, and upland ecosystems as well as a commensurate enhancement in wildlife functions and values.

Table 6-12 contains a comparison of the present and future extent of the wetland resource areas. In accordance with the Wetland Protection Act, most of the bank and bordering vegetated wetland would be altered in the process of restoration to future conditions.

Table 6-12

A Comparison of the Present and Proposed Future Extent of Resource Areas In Willow Pond As Defined in 310 CMR 10.00

Resource Area	Present	Future
Bank	800 lf	800 lf
Land Under Water	0.6 acres	0.5 acres
Bordering Vegetated Wetland	0.8 acres	0.8 acres
Bordering Land Subject To Flooding	Not Determined	No Change
Riverfront Area	Not Determined	No Change

6.5.2.5 Ecological Functions and Values

The proposed dredging activities in Willow Pond are described in Section 5.5.2.4. The dredging will deepen the pond providing a more suitable fish habitat (i.e. cooler temperatures, better oxygenation). After dredging activities are completed, invasive species such as purple loosestrife (*Lythrum salicaria)* will be removed. The method of vegetation removal is described in Section 5. The area will be replanted with a mixture of historical wetland and upland vegetation as listed in Table 6-2. Landscaping plans are provided in Appendix I.

Currently the wetlands around Willow Pond are narrow, and provide little habitat. The removal of nuisance aquatic vegetation along the bank and in the bordering vegetated wetlands (BVW) will benefit wildlife and will provide soil and sediment control. Replacement vegetation will benefit water fowl and avian species as a source of food and cover. In addition, much of the emergent vegetation will provide nesting areas for fish. The selected emergent species' extensive root systems also will help stabilize soil, thereby preventing erosion and further siltation. Examples of such species include sweet flag (*Acorus calamus*) and bur-reed (*Sparganium eurcarpum*). Emergent vegetation will be planted 12 inches on center. Two historic turf covered banks will be restored and an historic island that does not exist currently will be reconstructed in Willow Pond. The island will provide additional habitat to avian species, including safe and secluded nesting areas for ducks and geese.

Similar to work to be conducted in Land Under Water (LUW), invasive vegetation will be removed from the bank and BVW areas. In addition to purple loosestrife (*Lythrum salicaria)* and *Polygonum cupidatum*, other species such as *Rhamnus catharica* and *R. frangula* (common and European buckthorn,) also will be removed. Buckthorns rapidly invade areas and compete successfully with native species that provide more diverse habitat to a greater variety of species.

Banks and upland areas will be replanted with a mixture of historic wetland and upland plantings. Low shrubs such as *Xanthorhiza simplicissima* and *Rhus aromatica* will be planted 18 inches on center.

Wetland functions and values under proposed conditions were evaluated using the same methodology that was used to assess the existing conditions (see Section 4.6.2.5). The purpose of the Functions and Values Evaluation was to determine, in a non-biased manner, any ecological benefits that resulted from the proposed enhancement of the wetland, shoreline, and upland vegetation. The significance of the information in Table 6-13 is in the results of a comparison between the existing conditions (see Section 4.6.2.4 - Wetland Resources) and the proposed conditions. For Willow Pond and its surrounding area, there will be an overall increase in the ecological functions and values of flood flow alteration, fish habitat, sediment/toxicant retention, nutrient removal, product export, sediment/shoreline stabilization, wildlife habitat, and recreation.

6.5.3 Cultural Environment

6.5.3.1 Historic Resources

The footbridge at the southern end of the Pond and the culvert bridge at Willow Pond Road on the north side of the Pond are extant features from the Primary Period of Significance. These historic structures and other character defining features of the parkland will be protected so the impact to them will be minimal. The culvert bridge between Spring Pond and Willow Pond has integrity to the Primary Period, and will be restored, as will the adjacent rock placement on the banks of Willow Pond. Bridges where dredging will occur will also have limits placed in the specifications so dredging will not disturb footing structures.

During construction, the historic resources and vegetation will be protected with chain link fencing as needed including gated entries to the features, to exclude construction activities. Protection fencing will remain in place until final completion of all proposed adjacent work and then the protected areas will be restored in kind as required. Entrance and egress to these features will be signed to control, direct, and protect pedestrian and vehicular access.

The path system on the Boston side retains integrity to the Primary Period. However, a portion of the historic path from the Spring Pond to Willow Pond Road has become overgrown and the sides of the culvert bridge between Spring Pond and Willow Pond require repair. Paths on the Boston side are stonedust. On the Brookline or west side of the Pond, Riverdale Parkway was removed and replaced with a pedestrian path and a bikeway. Both the bikeway and pedestrian path are bituminous concrete. Willow Pond Road retains integrity to the Primary Period. Willow Pond Road and the path system on the west side of the pond will be impacted to provide access to the Pond for dredging operations. The use of the path systems will be restricted at different times during construction so movement within and across the park will be signed to control, direct, and protect pedestrian access during construction. During construction, path systems will be protected and if damaged during construction, they will be restored in kind as required.

Wetland Function-Value Evaluation Form

Total area of wetland_______Human made?____Is wetland part of a wildlife corridor? __________or a "habitat island"?

Adjacent land use____Recreation____________ Distance to nearest roadway or other development________________

Dominant wetland systems present Scrub Shrub/Emergent Contiguous underdeveloped buffer zone

present__No________

Is the wetland a separate hydraulic system?_No_________If not, where does the wetland lie in the drainage basin?______

How many tributaries contribute to the wetland?_1________Wildlife & vegetation diversity/abundance (see attached list)

Wetland I.D.
Latitude______Longitude________
Prepared by:________Date________
Wetland Impact:
Type______________Area________
Evaluation based on:
Office______________Field______
Corps manual wetland delineation
completed? Yes______No________

Function/Value	Occurrence Y	N	Rationale (Reference #)*	Principal Function(s)/Value(s)	Comments
Groundwater Recharge/Discharge		X	8, 13		No evidence of groundwater recharge or discharge.
Floodflow Alteration		X	3, 4, 5, 12,		Wetland is not large enough to hold significant amounts of flood waters.
Fish and Shellfish Habitat	X		3, 4, 7, 8, 10, 12, 14, 17.	X	Habitat will be improved as a result of the plantings
Sediment/Toxicant Retention	X		1,2, 3*,5,15,16*		Sediment retention will be improved due to the planting of shrubs and emergents.
Nutrient Removal	X		2, 4, 3*,6,8*,9,11*,12*9		Nutrient removal will improve with the planting of shrubs and emergents.
Production Export	X		1, 2, 4, 6, 7*,8, 12,		Proposed wetland vegetation includes species with high wildlife food value.
Sediment/Shoreline Stabilization	X		1, 3. 5, 9, 15,	X	Vegetation along the bank will provided stabilization in most areas.
Wildlife Habitat	X		2, 7, 8, 9, 14	X	Wetland will provide habitat to ducks and geese.
Recreation	X		1, 4, 7, 10, 11, 12	X	Wetland is easily accessible, and has some potential to function as educational and recreational area.

Table 6-13
Wetland Function-Value Evaluation Form for Willow Pond

Function/Value	Occurrence Y	Occurrence N	Rationale (Reference #)*	Principal Function(s)/Value(s)	Comments
Educational Scientific Value		X	3, 8, 9, 10, 12, 13,		Wetland is easily accessible, and has some potential to function as educational and recreational area.
Uniqueness/Heritage		X	1, 3, 8, 9, 10, 14, 16		
Visual Quality/Aesthetics		X	2, 7		Direct view of wetland and open water exist from the roadway.
ES Endangered Species Habitat	X		1, 2	X	Endangered species have been found in a portion of this pond
Other					

*Refer to back up list of numbered considerations.

Notes: Notes: *=Restoration goals are designed to provide and enhance these functions and values.

The 13 functions and values that are considered by the Regulatory Division for any Section 404 wetland permit are listed below. The list includes eight functions and five values. Values are grouped together at the end of the list.

These are not necessarily the only wetland functions and values possible. Not are they so precisely defined as to be unalterable. However, they do represent the best working 'palette' of descriptors, which can be used to paint an objective representation of the wetland resources associated with a proposed project.

Groundwater Recharge/Discharge--This function considers the potential for a wetland to serve as a groundwater recharge and/or discharge area. Recharge should relate to the potential for the wetland to contribute water to an aquifer. Discharge should relate to the potential for the wetland to serve as an area where groundwater can be discharged to the surface.

Floodflow Alteration (Storage & Desynchronization)--This function considers the effectiveness of the wetland in reducing flood damage by attenuation of floodwaters for prolonged periods following precipitation events.

Fish and Shellfish Habitat--This function considers the effectiveness of seasonal or permanent waterbodies associated with the wetland in question for fish and shellfish habitat.

Sediment/Toxicant/Pathogen Retention--This function reduces or prevents degradation of water quality. It relates to the effectiveness of the wetland as a trap for sediments, toxicants or pathogens.

Nutrient Removal/Retention/Transformation--This function relates to the effectiveness of the wetland to prevent adverse effects of excess nutrients entering aquifers or surface waters such as ponds, lakes, streams, rivers, or estuaries.

Product Export (Nutrient)--This function relates to the effectiveness of the wetland to produce food or usable products for human, or other living organisms.

Sediment/Shoreline Stabilization--This function relates to the effectiveness of the wetland to stabilize stream banks and shorelines against erosion.

Wildlife Habitat--This function relates to the effectiveness of the wetland to provide habitat for various types and populations of animals typically associated with wetlands and the wetland edge. Both resident and/or migrating species must be considered. Species lists of observed and potential animals should be included in the wetland assessment report.

Recreation (Consumptive and Non-Consumptive)--This value considers the effectiveness of the wetland and associated watercourses to provide recreational opportunities such as canoeing, boating, fishing, hunting and other active or passive recreational activities. Consumptive opportunities consume or diminish the plants, animals, or other resources that are intrinsic to the wetland, whereas non-consumptive opportunities do not.

Education/Scientific Value--This value considers the effectiveness of the wetland as a site for an 'outdoor classroom' or as a location for scientific research or study.

Uniqueness/Heritage--This value considers the effectiveness of the wetland or its associated waterbodies to produce certain special values.

Special values may include such things as archeological sites, unusual aesthetic quality, historical events, or unique plants, animals, or geological features.

Visual Quality/Aesthetics--This value relates to the visual and aesthetic qualities of the wetland.

ES **Threatened or Endangered Species Habitat**---This value considers the effectiveness of the wetland or its associated waterbodies to support threatened or endangered species.
Source: ACOE

The shoreline has been modified since the Primary Period and will again be impacted by the work of this project. The dredging operations, removal of invasive vegetation, and restoration of the waterfall and culvert bridge will all impact the shoreline. Since access of dredging equipment to the water will be limited, the only areas that will be impacted by dredging equipment entering and exiting the water will be these selected points of entry. All dredging operations will be conducted from the water. Areas that may be compacted by these operations will be aerated and restored upon completion of shoreline restoration and removal of invasive species.

The existing vegetation, except for heritage trees, has limited historical integrity for the Primary Period of Significance. The heritage trees will be protected to their drip line, pruned, and fertilized so impact to them should be minimal. Upland vegetation, including both trees and shrubs, which has been planted under recent projects will be protected so impact on them should be minimal. The lawn areas on the west side of the Pond will be impacted during access to the Pond during dredging. During construction, historic structures and vegetation to be protected will be enclosed with chain link protection fencing, which will remain in place until final completion of all proposed adjacent work and then the protected areas will be restored in kind as required.

6.5.3.2 Land Use

The current land uses surrounding the site will not be affected by the work of this project.

6.5.3.3 Recreation

Recreation in this area historically and currently has been passive. Treatment of this area under this project will retain the current passive recreation uses when the project is complete. The use of some passive areas will be restricted at different times during construction, such as during launching and retrieval of the dredge and bank restoration. Entrance and egress to the area will be signed to control, direct, and protect pedestrian and vehicular access during construction. Except for temporary interruptions, the pathways will be open during construction.

6.5.3.4 Pedestrian Access

As indicated on Figure 6-25, there are no planned temporary sidewalk or path closures in the Wards Pond area. As stated above, there may be temporary restrictions on use of the pathways while the pipelines are being placed/removed and the dredge is being launched/retrieved. The project does not negatively impact these relatively low pedestrian demands along Willow Pond Road.

6.5.4 Traffic

As Figure 6-25 indicates, the truck traffic to/from the Daisy Field Staging Area is proposed to be routed along Pond Avenue to Cypress Street to Route 9. This truck routing avoids several congested intersections along The Jamaicaway at Perkins Street. The expected project's impacts to traffic operations along Pond Avenue and

Cypress Street are minimal. There will be an increase in truck traffic along these roads. Because the periods of truck traffic activity will not coincide with peak traffic conditions in the area, there will be no negative impact to traffic operations during peak periods.

6.6 Assessment of Environmental Impacts at Wards Pond

Construction activities that are proposed within the Wards Pond area include:

- The improvement of the flood storage capacity by the dredging and removal of approximately 15,600 cubic yards (cy) of accumulated sediment,
- The preservation of the historic park shoreline through the restoration of the shoreline and outlet bridge to its historic intent,
- The preservation of the historic park features via the establishment of wetland species in the outlet brook from the Pond
- The restoration of the terrestrial habitat with indigenous plantings
- The repair or replacement of the worn pathways and denuded ground.

The proposed construction and re-vegetation activities are discussed in Section 5.0 - A Description of the Project's Design and Construction. The details are shown in the Preliminary Design Report provided in Appendix I.

The types of impacts that have been analyzed include those to the physical (hydrology, sediment, site access, etc) , chemical (water quality), biological (benthic macroinvertabrates, insects, fish, bird, vegetation, etc.), and human (pedestrian movement, traffic, site access, park use, etc.) environmental elements.

6.6.1 Physical Environmental Features

A consistent goal of the Muddy River Project is to provide as much ecosystem enhancement as possible. At Wards Pond, the proposed work includes deepening of the Pond, the restoration of the historic turf covered banks, the restoration and re-vegetation of the eroding beach at the Pond outlet, and the removal of large areas of Japanese knotweed and glossy buckthorn, both of which are invasive species. The physical environmental features around Wards Pond will be temporarily altered during construction. Long-term physical alterations are related to shoreline changes in the restoration of the historic turf covered banks, bank stabilization, deepening of the water body, and the enhancement of the aquatic and upland ecosystems to more natural ecosystems.

The Daisy Field staging area (see Figure 6-22) will be used for the dredging of Wards Pond. A 6-8 inch pipeline will be placed along existing pathways between the two locations through which the dredged materials will be pumped. The dredge will be lifted into the Pond with a crane from an appropriate location on the bank. Therefore, the disturbance of the physical environment will be temporary.

There will also be extensive temporary piping for the hydraulic dredging will be placed between Wards Pond and the Daisy Field Staging area. The piping will be placed in a manner that does not intrude with the pedestrians using the paths. When paths and roadways need to be crossed, the pipes will be placed in shallow trenches and covered with asphalt/stone dust. However, in order to minimize the amount of traffic disturbance, the pipes will be laid through the existing culverts and bridges whenever possible.

6.6.1.1 Hydrology

Being at the top of the Muddy River drainage system, Wards Pond does not have a direct impact on the exacerbation of downstream flooding (see Section 4.7.1.1). Therefore, while the dredging will deepen the Pond, there will be neither a negative nor a positive impact on downstream flooding.

6.6.1.2 Sediment Quality

Sediment that has accumulated in Wards Pond, and which will be removed (approximately 15,600 cy), consists of black organic silt, intermixed with fine to coarse sand and gravel. The native material underlying the silt layer was typically observed at two to eight feet below the top of the sediment. Native material consists of gray, medium dense to very dense sand with varying amounts of silt and /or fine gravel. Analytic results indicate that the sediments contain low levels of the analyses tested (see Appendix F- Sediment Characterization). Petroleum odors were observed to depths of six feet below the top of the sediment layer during drilling at the southern portion of Ward Pond. A sample collected from the northern portion of Wards Pond was well above the regulatory limit for TCLP lead at a concentration of 19 mg/L. This result is suspect given that the total lead concentration was 190 mg/kg. Since Wards Pond was not accessible by barge, additional sampling in this area below a depth of two feet could not be conducted to verify this sample result.

Accumulated sediments will be removed to a depth of about four feet. This will result in a slight improvement of sediment quality given that contamination was found at depths of four and below. However, the levels of contaminates in sediment are generally low in Wards Pond.

6.6.1.3 Water Quality

Wards and Willow Pond are the only two water bodies within the project limits where natural water flow may be greater than stormwater flow. Wards Pond receives water from groundwater seepage that occurs for the most part along the bank with Jamaica Pond, from a subsurface outlet in Jamaica Pond, as well as from a surface outlet weir in Jamaica Pond. Flow from Jamaica Pond is controlled via a gate valve at Wards Pond. Because the majority of water that enters Wards Pond is from the shallow subsurface in Jamaica Pond, the water is warm and generally representative of the low nutrient content water in Jamaica Pond. Water quality data is included in Appendix G.

During the dredging and reconstruction activities at Wards Pond, there will be turbid water that results from the dredging. The dewatering process will be conducted at the Daisy Field staging area where the return water will be discharged to Leverett Pond. During the dredging of Ward Pond, it proposed that the suspended solids not exceed 200% above background concentrations. A distance factor is not practical due to the limited size of thew water body. The re-grading of the unpaved pathway system and the eroding beach could also be a limited source of suspended solids during the early stages of reconstruction.

Prior to the final approval by the Department of Environmental Protection (DEP) and the Boston and Brookline Conservation Commissions, the Contractor will be required to submit a Stormwater/Dewatering Pollution Prevention Plan (S/DPPP) for approval by the project, the DEP and the Boston Conservation Commission before construction can proceed. The S/DPPP will contain an Erosion and Sedimentation Control Plan and a Spill Prevention Control and Countermeasure Plan (see Section 7.0 - Environmental Mitigation Plan). These Plans will state the Contractor's intent for managing site runoff, monitoring, and maintenance.

The removal of contaminated sediment will improve water quality by deepening of the Pond, reducing sediment oxygen demand, and increasing dissolved oxygen that, in turn, reduces nutrient and contaminant cycling from the sediments to the water. Wards Pond is also included in a long-term water quality monitoring program (see Section 7.0 - Environmental Mitigation Plan). Furthermore, the BWSC is implementing the city-wide Boston Catch Basin Maintenance Program that will also have a positive impact of the water quality in the Wards Pond area.

6.6.2 Biological Environment

The proposed Muddy River Project will result in the ultimate enhancement of the biological environment. This work includes the upland vegetation, wetlands, and aquatic and wildlife resources. However, in the course of conducting the dredging, construction and restoration work, temporary disturbances to the biological resources will result. The short-term and long-term impacts to the biological resources are included in the following sections.

6.6.2.1 Upland Vegetation and Horticultural Resources

The existing vegetation adjacent to the pond, at the point of access required to complete the work, will be impacted. Some vegetation will be removed to accomplish the work of this project. Parts of the shoreline around Wards Pond will be altered to provide for banks with improved grades for viewing. These are shown in the Preliminary Design Report in Appendix I. The upland vegetation adjacent to the project areas will be protected so impact to them should be minimal. In particular, every effort will be made to remove invasive vegetation such as Water Willow, Bittersweet, and Knotweed in areas that will be impacted by the proposed project.

The bank restoration and re-vegetation process will be staged such that the extent of bare ground will be minimized at any point in time. Silt fencing will be placed and maintained along all areas to be disturbed. As soon as bank re-grading work in as area is completed, the soil will be tilled and aerated and the area will either be sodded or mulched with pine bark in advance of the planting of vegetation. Sod will be pegged into the ground on slopes greater than 3:1. The wetland shelf will also be planted as soon after re-grading as possible.

When a disturbed area is to be restored, the surrounding silt fence will remain until grass is growing. Only then will it be removed and the ground were the fence had been will be raked level and seeded. Seeding will be conducted by hydromulching. Complete site restoration will be conducted within the first two months of the growing season.

6.6.2.2 Aquatic and Wildlife Resources

The existing aquatic and wildlife resources in Wards Pond area are limited. Wards Pond supports a warm water fishery that includes bottom-feeding species, pan fish, forage species and some predatory fish such as bass. The wildlife resources around Wards Pond include urban species that are adapted to high levels of human interference, as well as those that prefer natural habitat and diversity.

Benthic Resources

The benthic resources will be the most severely impacted aquatic community from the dredging. Because the peripheral vegetation in Wards Pond will not be dredged, there will be a rich source of benthic species to re-colonize the new bottom. Additionally, because the littoral zone will remain essentially intact, it will provide an escape area for fish. Therefore, the extent of impacts to the benthic resources will be reduced and recruitment period will also be shortened.

Fish Resources

During dredging there will be some mortality of fish. The mortality rate may be proportionally higher for any bottom dwelling species (carp, suckers) than the open water species (sunfish, pickerel). This impact is not considered adverse, however, because the water quality in Wards Pond would benefit from substantially fewer bottom dwelling species that enhance the cycling of nutrients and contaminants to the water. In addition, because the littoral zone will remain essentially intact, it will provide an escape area for fish. The removal of sediment from Wards Pond will result in an enhanced aquatic habitat for fish resources. The removal of contaminated sediment will lead to reductions in the sediment oxygen demand, and less nutrient and contaminant cycling from the sediments to the water. It is unlikely that the dredging will result in improved fish spawning habitat.

Wildlife Resources
The positive long-term impacts to wildlife resources in Wards Pond and its surrounding area will outweigh the negative effects. A minimal disturbance to avian existing species may occur during dredging and re-vegetation as the birds relocate to areas of less disturbance. The planting of larger areas of trees and shrubs will attract greater numbers of birds after the construction has been completed. In locations where dredging takes place during winter hibernation, amphibian and reptile species will not be able to escape the dredging and will die. During the summer, there will be less mortality, as these species will be able to move from the dredging and into the littoral zone where sufficient sediment will remain to accommodate some displaced amphibians and reptiles.

The removal of Japanese knotweed and glossy buckthorn and their replacement with plant massings that contain a higher species and habitat diversity will result in an increase of habitat diversity due to the improved composition of the aquatic, wetland, shrub and tree canopy components of the ecosystem. The proposed planting plan is shown in detail in the Preliminary Design Report contained in Appendix I. Figures 6-27 and 6-28, taken from the Preliminary Design Report, are illustrations of the re-vegetation that is proposed for Wards Pond. The proposed shrub and tree species that are listed in Table 6-2 were selected from the original Olmsted design. The list includes 20 species of shrubs and tress from the original Olmsted planting list, six species of shoreline plants, and eleven species of emergent wetland plants. There is no plan to introduce submersed aquatic species because they will colonize the aquatic environment as seeds are introduced by waterfowl and upstream sources.

The rodent control program that will be used in downstream locations will not take place at Wards Pond. Save for a few muskrats, there is no evidence of rodents. Because the banks themselves will not be disturbed, rodent control is not considered necessary. However, in order to minimize future goose population in Wards Pond, there will be a multi-faceted program for goose control. This is described in Section 8 - Management and Maintenance.

The habitat in those areas where removal of Japanese knotweed and glossy buckthorn is proposed will be restored with an indigenous plant community. The primary goal of this restoration process is to create a healthy ecosystem containing a variety of plant communities (i.e., diversity) ultimately resulting in the development of significant and valuable structural heterogeneity. This diverse habitat is preferred by a wide-variety of avian, mammalian and invertebrate species. Wading birds such as great blue heron, green heron and black-crowned night heron will take advantage of bank habitat. The interface or edge effect between terrestrial and aquatic environments (the ecotone) provides significant food sources, shelter, breeding and nesting areas for a variety of invertebrates, including dragonflies, butterflies and

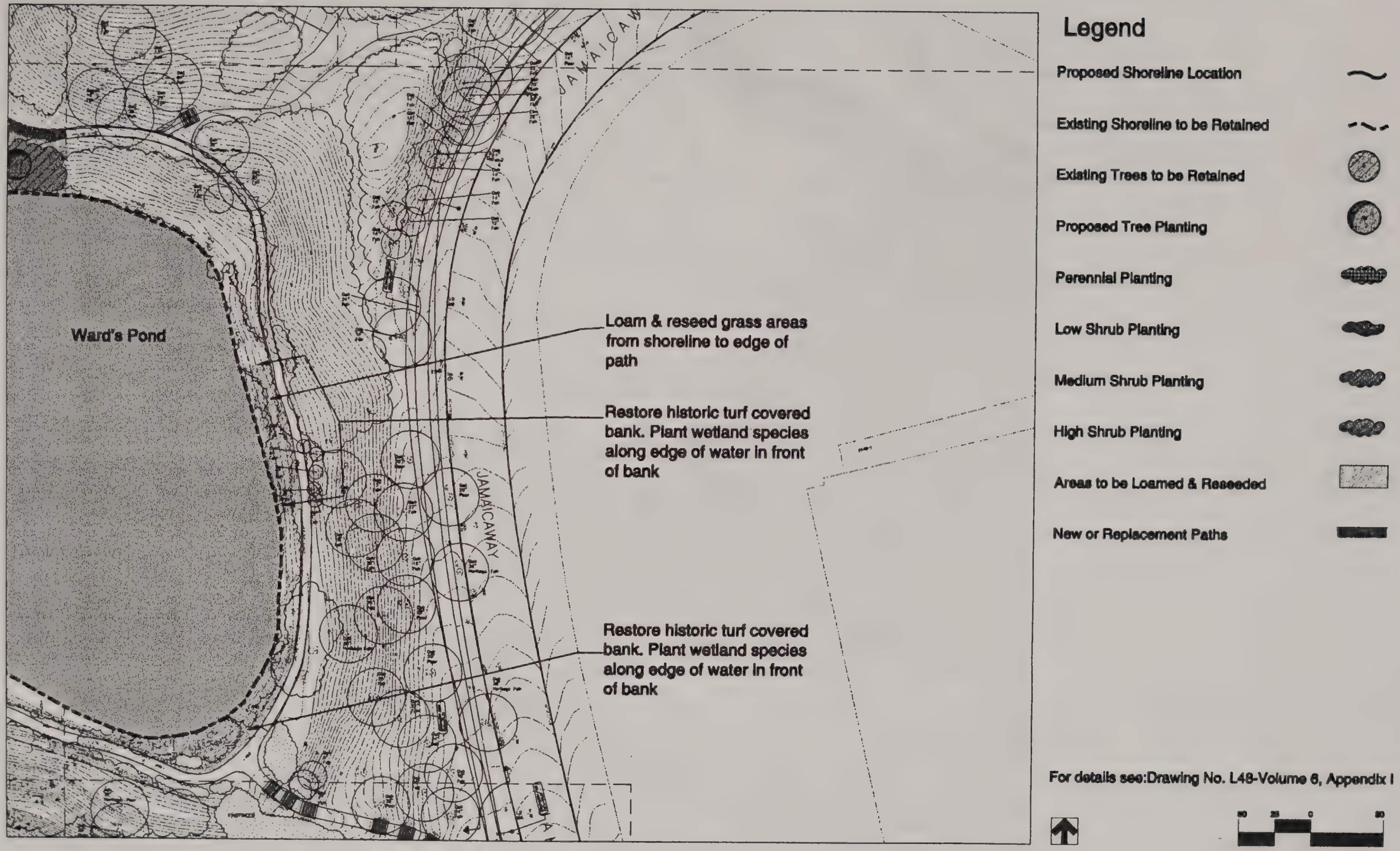

Ward's Pond
JAMAICAWAY
Loam & reseed grass areas from shoreline to edge of path
Restore historic turf covered bank. Plant wetland species along edge of water in front of bank
Restore historic turf covered bank. Plant wetland species along edge of water in front of bank
Legend
Proposed Shoreline Location
Existing Shoreline to be Retained
Existing Trees to be Retained
Proposed Tree Planting
Perennial Planting
Low Shrub Planting
Medium Shrub Planting
High Shrub Planting
Areas to be Loamed & Reseeded
New or Replacement Paths
For details see:Drawing No. L48-Volume 6, Appendix I

Figure 6-27
Typical Plant Massing Proposed for Wards Pond, West
Source: Pressley, Inc.

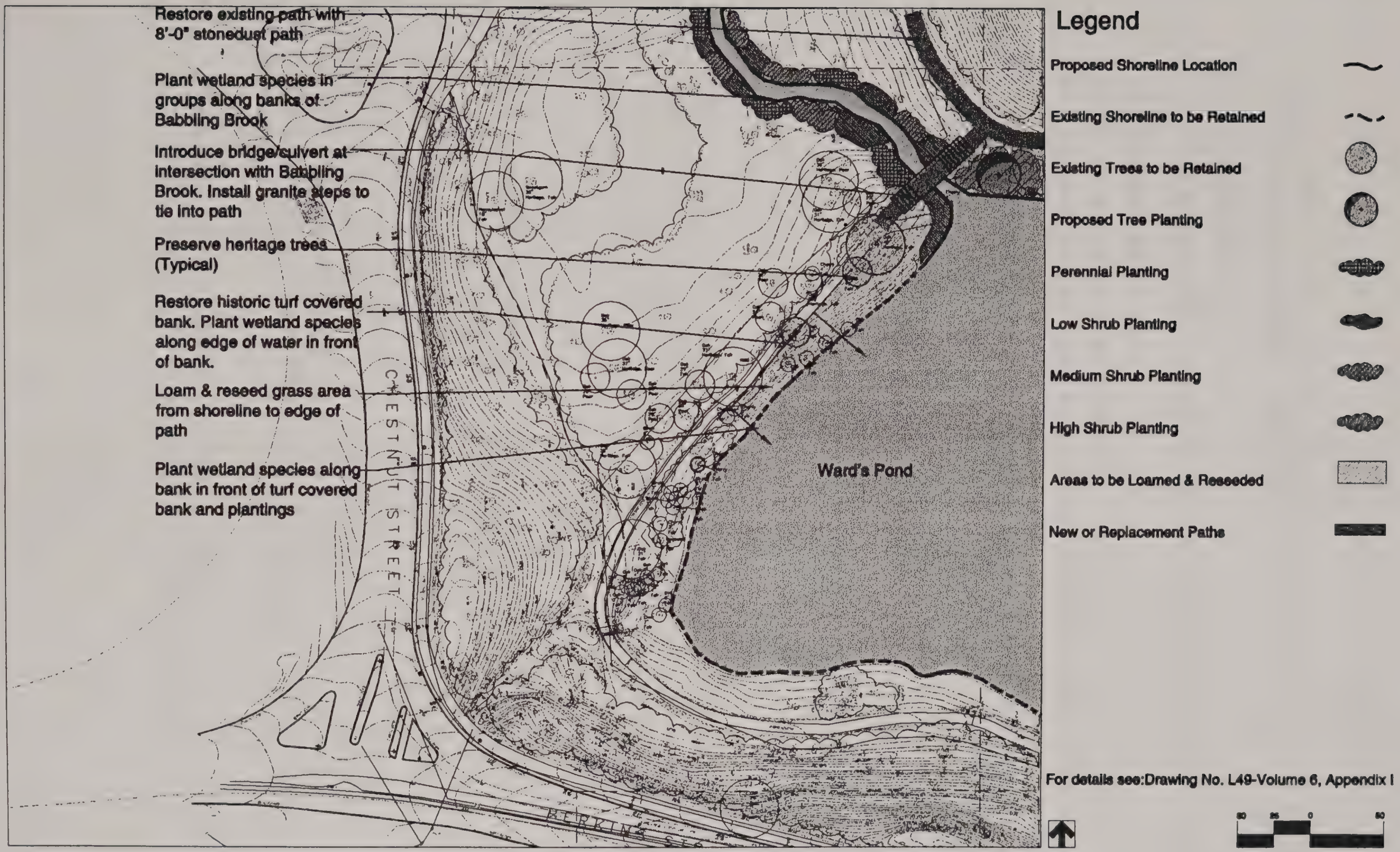

Restore existing path with 8'-0" stonedust path
Plant wetland species in groups along banks of Babbling Brook
Introduce bridge/culvert at intersection with Babbling Brook. Install granite steps to tie into path
Preserve heritage trees (Typical)
Restore historic turf covered bank. Plant wetland species along edge of water in front of bank.
Loam & reseed grass area from shoreline to edge of path
Plant wetland species along bank in front of turf covered bank and plantings
CHESTNUT STREET
PERKINS ST
Ward's Pond
Legend
Proposed Shoreline Location
Existing Shoreline to be Retained
Existing Trees to be Retained
Proposed Tree Planting
Perennial Planting
Low Shrub Planting
Medium Shrub Planting
High Shrub Planting
Areas to be Loamed & Reseeded
New or Replacement Paths
For details see:Drawing No. L49-Volume 6, Appendix I
50
25
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Figure 6-28
Typical Plant Massing Proposed for Wards Pond, East
Source: Pressley, Inc.

beetles. They, in turn, provide food sources for all growth levels (larval, pupa and adult) for avian and small mammal species.

6.6.2.3 Rare Species

The Wards Pond area does not contain any rare, endangered or threatened species.

6.6.2.4 Wetland Resources

The shoreline of Wards Pond is vegetated with a greater variety of wetland plants than exists elsewhere along the Muddy River (see Section 4.7.2.4). There is an expanding band of water willow around the majority of the Pond. Cattail, alder, jewel weed, purple loosestrife, sensitive fern, dogwood, birch, and other plants also inhabit the pond's periphery. The glossy buckthorn and Japanese knotweed, both invasive species, will be removed followed by the introduction of the plant species that are listed in Table 6-2. This restoration will result in the increase in the diversity of wetland and upland vegetation. Three historic turf covered banks will also be restored by removing the existing shoreline and emergent vegetation that generally includes buckthorn, knotweed, alder, and water willow and replacing it with emergent wetland vegetation that is shown in Table 6-2. The plans include the restoration of the historic turf covered banks that once existed at the Wards Pond beaches.

Table 6-13 contains a comparison of the present and future extent of the wetland resource areas. In accordance with the wetland Protection Act, less than 25% of the bank and bordering vegetated wetland would be altered in the process of restoration to future conditions.

Table 6-14

A Comparison of the Present and Proposed Future Extent of Resource Areas at Wards Pond As Defined in 310 CMR 10.00

Resource Area	Present	Future
Bank	1,260 lf	1,260 lf
Land Under Water	1.8 acres	1.8 acres
Bordering Vegetated Wetland	0.6 acres	0.4 acres
Bordering Land Subject To Flooding	Not Determined	No Change
Riverfront Area	Not Determined	No Change

A summary of all wetland resources from Back Bay Fens to Wards Pond is included in Table 6-15. This table shows no net loss of wetlands for proposed project.

Table 6-15

A Comparison of Present and Proposed Future Extent of Resource Areas in Project Area as defined in 310 CMR.10.00

Resource Area	Present	Future
Bank	32,810 lf	33,770 lf
Land Under Water	37.9 ac.	38.6 ac.
Bordering Vegetated Wetland	2.9 ac.	2.9 ac.
Bordering Land subject to Flooding	Not Determined	No Change
Riverfront Area	Not Determined	No Change

6.6.2.5 Ecological Functions and Values

The proposed dredging activities in Wards' Pond are described in Section 5.5.1.5. These activities will deepen the Pond, providing a more suitable fish habitat (i.e. cooler temperatures, better oxygenation). After dredging activities are completed, invasive species such as purple loosestrife (*Lythrum salicaria),* japanese knotweed (*Polygonum cuspidatum*), and buckthorns (*Rhamnus sps.*) will be removed. The method of vegetation removal is described in Section 5. In addition, three historic turf covered beaches will be restored, necessitating the removal of some water willow (*Decodon verticillatus*) and alder. The area will be replanted with a mixture of historical wetland and upland vegetation as listed in Table 6-2. Proposed landscaping plans are provided in Appendix I.

The removal of nuisance aquatic vegetation along the bank and in the bordering vegetated wetlands (BVW) will benefit wildlife and provide soil and sediment control. A swath of emergent vegetation will be planted 12 inches on center along the entire perimeter of the pond.

Similar to work to be conducted in Land Under Water (LUW), invasive vegetation will be removed from the bank and BVW areas. Species such as purple loosestrife (*Lythrum salicaria), Polygonum cipidatum ,Rhamus catharica* and *R. frangula* (common and European buckthorn,) will be eliminated. *Rhamnus sps.* (buckthorns) are listed as invasive plants in Massachusetts. Buckthorns invade areas rapidly, competing successfully with native species that provide more diverse habitat for a greater variety of species.

Banks and upland areas will be replanted with a mixture of historic wetland and upland plantings. Low shrubs such as *Xanthorhiza simplicissima* and *Rhus aromatica* will be planted 18 inches on center.

Wards Pond currently has a well-established mix of emergent and scrub-shrub wetlands. The present wetland functions and values are considered adequate to high. The replanting will not degrade or lessen the functions or values, but may provide equal or better wildlife habitat and stabilization of banks. Wetland functions and values will remain the same for the area under the proposed conditions (see Table 6-16).

6.6.3 Cultural Environment

6.6.3.1 Historic Resources

The footbridge at Pond Avenue that crosses the Babbling Brook, the small culvert footbridge on the southwest corner of the pond, the granite steps that descend from the junction of Perkins Street and The Jamaicaway, and granite steps at the southeast corner of the Pond, are the historical features extant from the Primary Period of Significance. These historic structures and other parkland character defining features will be protected so impact to them will be minimal. Protection of the footbridge over the Babbling Brook is the most critical. During construction the historic resources and vegetation will be protected with chain link fencing as needed including gated entries to the features to exclude construction activities. Protection fencing will remain in place until final completion of all proposed adjacent work and then the protected areas will be restored in kind as required. Entrance and egress to these features will be signed to control, direct, and protect pedestrian and vehicular access.

The path system surrounding, and to the pond, retains integrity to the Primary Period. However, the southern path has be modified by the construction of a wooden boardwalk, which allows access over an area that has become a wetland where the Olmsted designed park provided a path system. The path system will be impacted on the northwestern corner of the pond. The path system on the northwest, from Pond Avenue to the pond, will also be impacted by the work of this project. The path system is a stone dust path at the Pond and bituminous concrete from the footbridge to Pond Avenue. Entrance and egress to the area will be signed to control, direct, and protect pedestrian and vehicular access. Access to the existing parking lot may also have to be restricted during construction.

The shoreline grading has had minimal modification since the Primary Period of Significance. The shoreline will be minimally impacted by the bank to bank dredging of the Pond under this contract. Since access of dredging equipment to the water will be limited, the only areas that will be impacted by dredging equipment entering and exiting the water will be these selected points of entry. All dredging operations will be conducted from the water. Areas that may be compacted by these operations will be aerated and restored upon completion of dredging and restoration of disturbed shoreline.

Wetland Function-Value Evaluation Form

Total area of wetland_______Human made?____Is wetland part of a wildlife corridor? __________or a "habitat island"?

Adjacent land use____Recreation____________ Distance to nearest roadway or other development________________

Dominant wetland systems present Scrub Shrub/Emergent Contiguous underdeveloped buffer zone

present__No________

Is the wetland a separate hydraulic system?_No_________If not, where does the wetland lie in the drainage basin?______

How many tributaries contribute to the wetland?_1________Wildlife & vegetation diversity/abundance (see attached list)

Wetland I.D.
Latitude______Longitude________
Prepared by:________Date_______
Wetland Impact:
Type______________Area_______
Evaluation based on:
Office_____________Field______
Corps manual wetland delineation
completed? Yes______No_______

Function/Value	Occurrence		Rationale (Reference #)*	Principal Function(s)/Value(s)	Comments
	Y	N			
Groundwater Recharge/Discharge	X		7, 8, 12, 13, 15		Evidence of groundwater discharge from seeps in hillside
Floodflow Alteration		X	3, 4, 5, 9,12		Wetland is not large enough to hold significant amounts of flood waters.
Fish and Shellfish Habitat	X		3, 4, 7, 10, 12, 14		Pond provides fisheries habitat.
Sediment/Toxicant Retention		X	1,2,15		Wetlands are narrow, however provide some sediment retention.
Nutrient Removal	X		2, 4, 6, 9		Wetlands are narrow, however provide some nutrient retention.
Production Export	X		1, 2, 4, 6, 8, 12,		Plants in the wetland provide some wildlife food qualities.
Sediment/Shoreline Stabilization	X		1, 3. 5, 9, 15,		Wetlands are narrow, however provide some sediment retention.
Wildlife Habitat	X		2, 7, 8, 9, 14	X	Diverse area for urban wildlife to exist.
Recreation	X		1, 4, 7, 10, 11, 12	X	Wetland is easily assessable and has a boardwalk. Recreation does occur.

Table 6-16
Wetland Function-Value Evaluation Form for Ward's Pond

Function/Value	Occurrence Y	 N	Rationale (Reference #)*	Principal Function(s)/Value(s)	Comments
Educational Scientific Value		X	3, 8, 9, 10, 12, 13,		Potential for education site walks. No known educational uses.
Uniqueness/Heritage		X	1, 3, 6, 8, 9, 10, 13, 14, 16, 18,		
Visual Quality/Aesthetics	X		2, 7		Wetland is most natural in whole Emerald Necklas System
ES Endangered Species Habitat		X			none found or known to occur here
Other					

*Refer to back up list of numbered considerations.

Notes:

The 13 functions and values that are considered by the Regulatory Division for any Section 404 wetland permit are listed below. The list includes eight functions and five values. Values are grouped together at the end of the list.

These are not necessarily the only wetland functions and values possible. Not are they so precisely defined as to be unalterable. However, they do represent the best working 'palette' of descriptors, which can be used to paint an objective representation of the wetland resources associated with a proposed project.

Groundwater Recharge/Discharge--This function considers the potential for a wetland to serve as a groundwater recharge and/or discharge area. Recharge should relate to the potential for the wetland to contribute water to an aquifer. Discharge should relate to the potential for the wetland to serve as an area where groundwater can be discharged to the surface.

Floodflow Alteration (Storage & Desynchronization)--This function considers the effectiveness of the wetland in reducing flood damage by attenuation of floodwaters for prolonged periods following precipitation events.

Fish and Shellfish Habitat--This function considers the effectiveness of seasonal or permanent waterbodies associated with the wetland in question for fish and shellfish habitat.

Sediment/Toxicant/Pathogen Retention--This function reduces or prevents degradation of water quality. It relates to the effectiveness of the wetland as a trap for sediments, toxicants or pathogens.

Nutrient Removal/Retention/Transformation--This function relates to the effectiveness of the wetland to prevent adverse effects of excess nutrients entering aquifers or surface waters such as ponds, lakes, streams, rivers, or estuaries.

Product Export (Nutrient)--This function relates to the effectiveness of the wetland to produce food or usable products for human, or other living organisms.

Sediment/Shoreline Stabilization--This function relates to the effectiveness of the wetland to stabilize stream banks and shorelines against erosion.

Wildlife Habitat--This function relates to the effectiveness of the wetland to provide habitat for various types and populations of animals typically associated with wetlands and the wetland edge. Both resident and/or migrating species must be considered. Species lists of observed and potential animals should be included in the wetland assessment report.

Recreation (Consumptive and Non-Consumptive)--This value considers the effectiveness of the wetland and associated watercourses to provide recreational opportunities such as canoeing, boating, fishing, hunting and other active or passive recreational activities. Consumptive opportunities consume or diminish the plants, animals, or other resources that are intrinsic to the wetland, whereas non-consumptive opportunities do not.

Education/Scientific Value--This value considers the effectiveness of the wetland as a site for an 'outdoor classroom' or as a location for scientific research or study.

Uniqueness/Heritage--This value considers the effectiveness of the wetland or its associated waterbodies to produce certain special values. Special values may include such things as archeological sites, unusual aesthetic quality, historical events, or unique plants, animals, or geological features.

Visual Quality/Aesthetics--This value relates to the visual and aesthetic qualities of the wetland.

ES **Threatened or Endangered Species Habitat**---This value considers the effectiveness of the wetland or its associated waterbodies to support threatened or endangered species.

Source: ACOE

The existing vegetation, except for heritage trees, has limited historical integrity for the Primary Period of Significance. The area has a larger number then other areas of the park system of invasive species that have grown over paths, obliterated historic viewsheds, and choked out the more valuable species. The heritage trees will be protected, pruned, and fertilized so the impact to them should be minimal. Upland vegetation that is adjacent to the work will be protected so the impact on them should be minimal. During construction, historic structures and vegetation will be enclosed with chain link protection fencing, which will remain in place until final completion of all proposed adjacent work and then the protected areas will be restored in kind as required.

6.6.3.2 Land Use

The current land uses surrounding the site will not be affected by the work of this project. The dredging of Wards Pond and the re-vegetation of the shoreline will result in a temporary disturbance to the use of the pathways around the Pond. However, there will not be any long-term negative impact to the use of Wards Pond or its surrounding parkland.

6.6.3.3 Recreation

Recreation in this area historically and currently has been passive. Treatment of this area under this project will retain the current passive recreation use when the project is complete. The use of some passive areas will be restricted at different times during construction. Entrance and egress to the area will be signed to control, direct, and protect pedestrian and vehicular access during construction.

6.6.3.4 Pedestrian Access

As indicated on Figure 6-25, there are no planned long-term sidewalk or path closures in the Wards Pond area. During launching and retrieving of the dredge and laying and removal of pipeline, there may be temporary restrictions on pathways. After these activities are completes, the pathways will be open.

6.6.4 Traffic

As Figure 6-25 indicates, the truck traffic to/from the Daisy Field Staging Area is proposed to be routed along Pond Avenue to Cypress Street to Route 9. This truck routing avoids several congested intersections along The Jamaicaway at Perkins Street. The expected project impacts to traffic operations along Pond Avenue and Cypress Street are minimal. There will be an increase in truck traffic along these roads. Because the periods of truck traffic activity will not coincide with peak traffic conditions in the area, there will not be a negative impact to traffic operations during peak periods.

7

Section Seven

Section 7
Environmental Mitigation

The proposed Muddy River Project consists of the following environmental enhancement and mitigation objectives:

- Provide Flood Control – Maintain the flood elevation in the Riverway at 15 ft. BCB and to remove other flow restrictions;
- Improve Water Quality Improvement – Contribute to the attainment of Class B Water Quality Standards in Muddy River;
- Enhance Aquatic and Riparian Habitat – Increase the size/volume, quality, and diversity of the aquatic and riparian habitat;
- Restore Landscape and Historic Resources – Contribute to the restoration of historic landscape and historic resources while maintaining the Continuum; and
- Institute Best Management Practices for Stormwater Runoff – Reduce the pollutant loading and contribute to the attainment of Class B Water Quality Standards in the Muddy River.

In order to fulfill these objectives, it is necessary that dredging of contaminated sediments be conducted along with some infrastructure improvements. Equally important is the revegetation of aquatic and riparian habitat lands with a diverse composition of wetland, shoreline and upland plantings. The realization of this work will result in an exceedingly enhanced environmental setting over that which presently exists.

The proposed construction will result in the temporary disturbance of the Muddy River, public uses of portions of the parklands, roadways and pedestrian walkways. The following environmental mitigation measures have been developed to minimize the degree of negative construction-related impacts. The proposed mitigation measures for the Charlesgate area and the remainder of the construction are summarized in Table 7-1. There are also several measures and plans that are proposed to ensure the long-term benefits of the construction phase of the project. The post-construction implementation plans involve the MEPA Annual Update (see Section 9.0), a Management and Maintenance Plan (see Section 8.0), and the implementation of Best Management Practices for stormwater runoff (see Section 5.0). The MEPA Annual Update will be viewed as the compliance report, which will detail the level of compliance with the FEIR Certificate and the other permits and approvals.

The proposed construction is scheduled to take place in two segments. The first will include the dredging and construction in the Charlesgate area and the second will be for the remainder of the project from the Back Bay Fens through Wards Pond.

IMPACTS	MITIGATION
General Project Impacts	
1. Upland disturbance during construction	Employ hydraulic dredging and removal of invasives from water as much as possible
2. Loss of Bordering Vegetative Wetlands	Replacement of BVW with no loss of BVD due to construction
3. Loss of habitat	Replanting of wetland and riparian vegetation for net increase in bio diversity and function and value of the habitat
4. Re-sedimentation of river area basins	BMPs including in-stream sedimentation
5. Potential harm/damage to historic features along waterway	Restoration of Fens Bridge upstream headwall, construction of culvert replacements in the style of historic structures, protection of historical features
Construction Impacts	
1. Truck parking during sediment and removal	Use off-site private parking and use of construction staging area for truck mobilization
2. Traffic Impacts	Modification of traffic light timing to improve flow, limit hours of construction during major events in Fenway area, provide construction coordinator as liaison for area institutions, contractor to provide traffic management plans for construction activities, define truck routes, off site parking for construction crews
3. Turbidity during dredging (protection of anadromous fish)	Silt curtains, filtering of dewatering effluent, water quality monitoring during construction and establish effluent limits
4. Potential loss of fish	Restock fish at end of construction
5. General environmental construction impacts	Provide independent environmental monitor
6. Disturbance of park areas and property during construction	Replacement in kind of all area disturbed and maintained for period of 2 years, protection of vegetation and historic structures during construction
7. Air quality during construction	Use of natural gas generators during construction or investigate use of electric power where feasible, follow truck idling regulation
8. Flooding control during construction	Maintenance of a flow channel and addition of temporary pumping facilities, develop a contractors storm response plan
9. Dust	Use of dust control measures such as calcium chlorite, frequent street sweeping, wheel washes
10. Loss of parking	Minimal effects anticipated, no replacement at this time
11. Loss of pedestrian access	Construction and maintenance of temporary pedestrian access in areas where feasible, notification through media of access conditions
12. Public safety at staging areas	Construction of temporary fencing with locked gates
13. Noise	Specification of noise limits and use of periodic noise monitoring devices
14. Disturbing rodent habitat	Use licensed pest control agent to prevent rodents leaving site
15. Odors	Cover dewatering equipment if necessary, maintain odor control foam on site
16. Visual	Include wind curtains on staging area fencing to block views of staging areas

Table 7-1
Mitigation of Project Impacts

Therefore, this section on environmental mitigation is presented in the same sequence.

7.1 Mitigation Management

Management of the Muddy River Project will include the project proponents, City of Boston and the Town of Brookline, as well as the Department of Environmental Management. The Boston Parks and Recreation Department will serve as the contracting agency and will administer the Project. Should the Army Corps of Engineers fund the Project, the BPRD will administer the contract for the Charlesgate Area dredging, and the ACOE will administer the contract(s) for the balance of the work. As part of this structure, the management team will be responsible for managing the Contractor's operations and adherence to contract provisions to mitigate construction impacts. The on-site Resident Engineer will monitor work and report any deficiencies to the Proponent Administrator for corrective action with the Contractor. The Muddy River Project's construction management structure is shown in Figure 7-1.

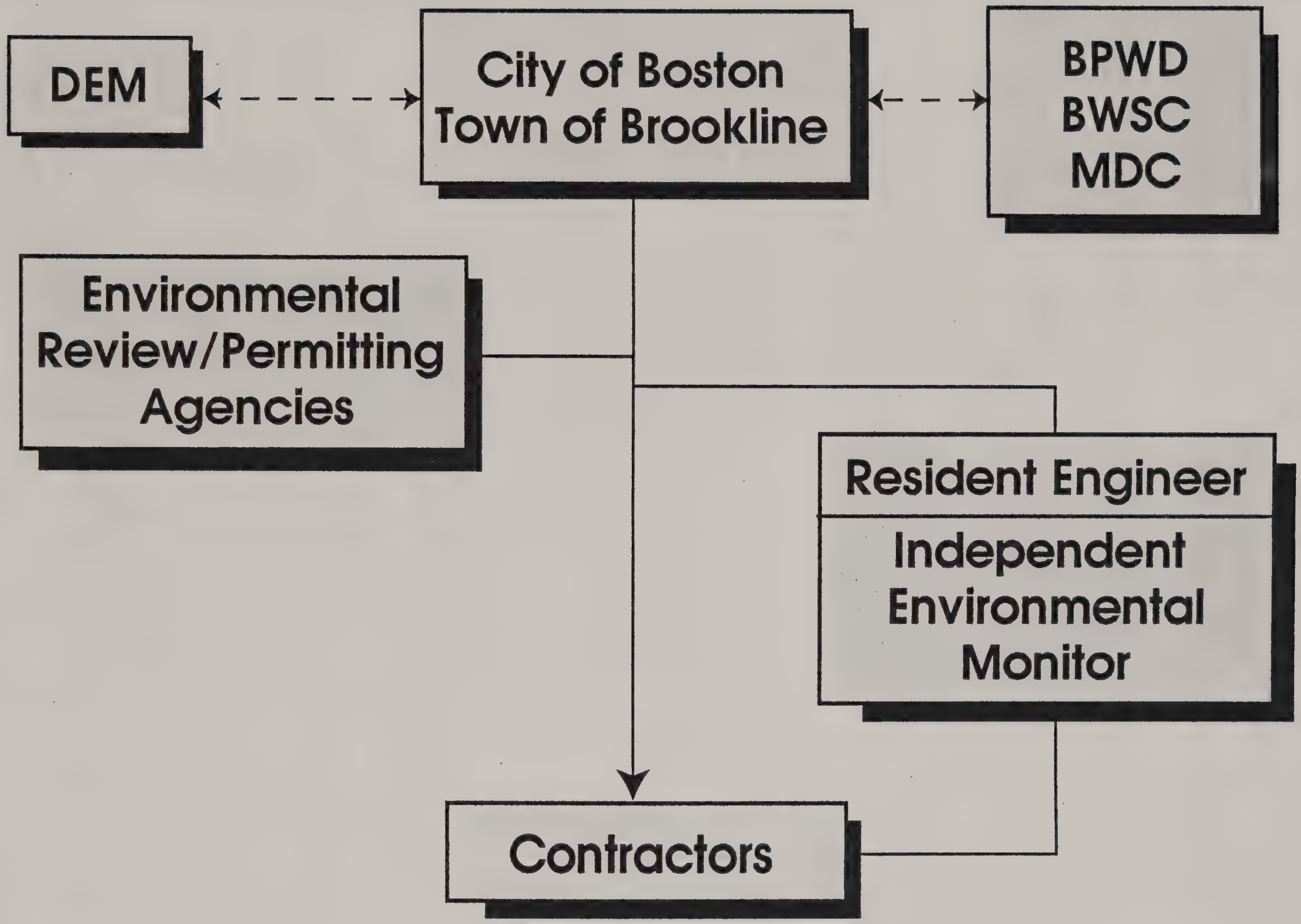
In addition, to ensure compliance with the requirements of all the project's environmental permits and approvals, an Independent Environmental Monitor (IEM) will be retained by the Project Proponent as part of the on-site inspection team to work with the Resident Engineer. The IEM's responsibilities include conducting the environmental inspections (the Contractor will conduct the monitoring and submit the results to the IEM), coordinating with Conservation Commissions with jurisdiction, the review agencies, and preparing and submitting the inspection reports. The IEM will report deficiencies to the Proponent Administrator with the Resident Engineer.

The Contractor's environmental submittals and data will be reviewed as directed by the management team for compliance with contract documents and permit conditions including mitigation measures.

7.2 Environmental Mitigation for Construction Activities in the Charlesgate Area

Construction activities that are proposed within the Charlesgate Area include:

- The creation of a staging area for dredging and material processing equipment including belt filter presses and other appurtenances,
- The removal of waterway obstructions,
- The dredging and removal of approximately 3,300 cubic yards (cy) of accumulated sediment and debris,
- The restoration and revegetation of the staging area upon completion of the work,
- The planting of new vegetation,
- The repair or replacement of worn pathways, and
- Installation of new park benches and trash barrels.



Note: If the U.S. Army Corps of Engineers conducts portions of projects, this structure would be modified.

Figure 7-1
Construction Management Structure

The anticipated impacts during the proposed dredging and restoration activities in the Charlesgate area include those associated with runoff from the staging area, increased turbidity and suspended solids during dredging, truck traffic, noise from the dredge, generator, and other power and backup beepers. The proposed mitigation efforts for each of these are summarized in Table 7-1. The following subsections describe the plans required from the Contractor to implement these mitigation measures.

7.2.1 Dredged Materials Management Plan

The sediments to be dredged have been characterized to determine the appropriate management activities for their removal from the Muddy River, dewatering, and ultimate disposal. The quality of the sediment in the Charlesgate area is suitable for management at Massachusetts DEP-approved unlined landfills. To ensure that the Contractor will protect the environmental and historical setting, the Contractor will be required to submit a Dredged Materials Management Plan (DMMP). The DMMP will be the Contractor's obligation for environmental compliance. The DMMP will contain the following information:

- Project Objectives
- Existing Sediment Quality
- Existing Water Quality
- Existing Aquatic, Wetland, and Upland Biological Resources
- Historical and Architectural Resources Structural and Geographic Limitations to Dredging, Equipment, and Materials Management
- Dredged Material Management
  - Proposed Dredging Methods
    - Hydraulic
    - Excavator
    - Dredging Equipment and Performance Criteria
    - Compatibility of the Dredging Equipment with Disposal Methodology
  - Dredging Sequence
  - Dewatering and Sediment Stabilization
  - Water Quality Mitigation Measures During Hydraulic Dredging, Siltation Control
- Upland Support Requirements, Staging Areas
- Operational Controls
- Traffic Management
  - Mobilization
  - Truck Queuing and Engine Idling Restrictions
- Pedestrian Movement
- Trash and Debris Removal
- Noise Control
- Dust Control
- Odor Control
- Repair of Damaged Landscaping and Vegetation

- Schedule
- Regulatory Requirements
- Water Quality Monitoring
- Parkland Monitoring
- Contingency Plan In the Event That Uncontrollable Environmental Problems Occur
- Emergency Response Plan and a Spill Prevention Control Containment and Countermeasure Plan (Title 29 CFR 1910.120 of OSHA Standards, 40 CFR 112, FEMA Emergency Plan Requirements, Section 105 of CERCLA, Massachusetts Right-to-Know Act and other local, state and federal requirements, as appropriate)

At special space-limited locations where dredging with excavators will be necessary, the area will be enclosed with a silt curtain to minimize the spread of turbid water into the Charles River. A silt curtain and oil adsorbent boom (see Figure 7-2) will also be maintained at the conduit under Storrow Drive to prevent floating debris and sheens from entering the Charles River. Oil absorbent materials will be maintained at the booms. The silt curtain and absorbent materials will be inspected daily and accumulated debris and trash will be collected and the absorbent pads will be replaced as needed.

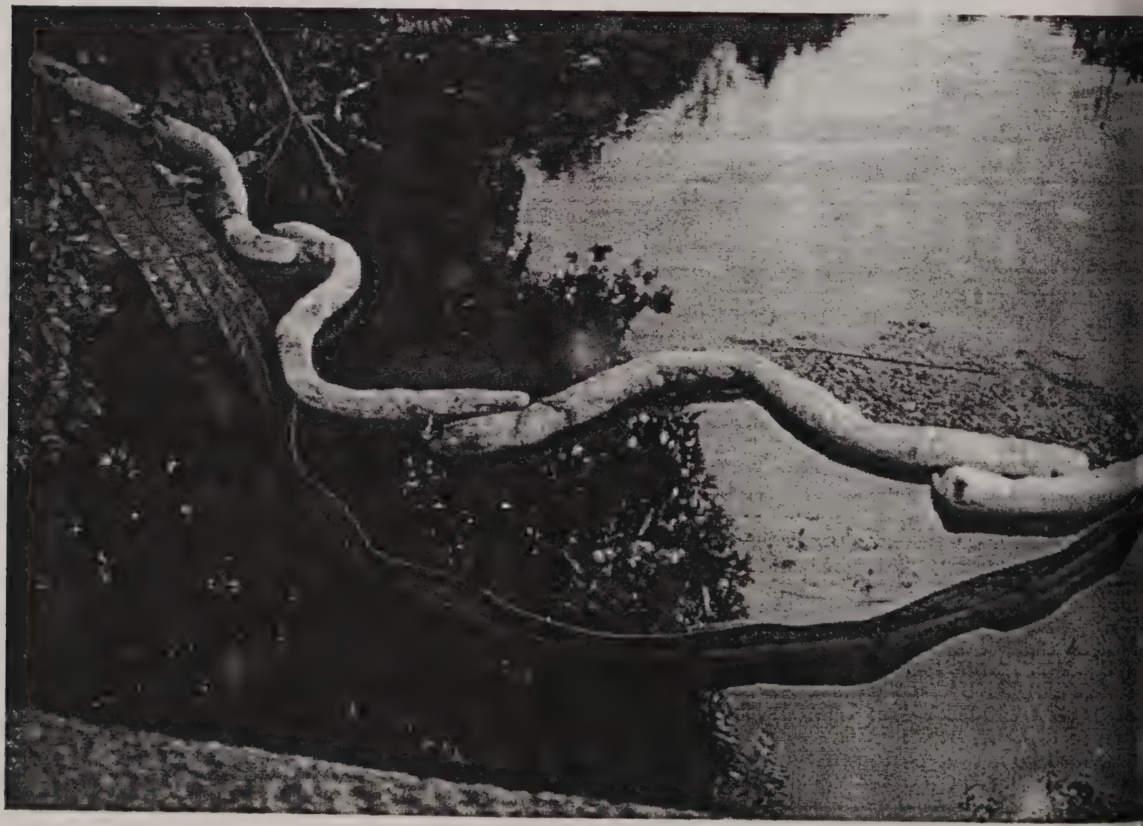


Figure
Silt Curtain and Oil Absorbent Bo

The Contractor will submit the DMMP for review and acceptance.

7.2.2 Stormwater/Dewatering Pollution Prevention Plan

In order to provide a workable surface, it is expected that the Contractor will form staging area by placing a moderately dense layer of gravel and stone over the existing ground. In this manner the underlying soil will remain essentially undisturbed and the potential for erosion will be considerably minimized. The staging area will contain sedimentation tanks, pumps, coagulant polymer feed systems, belt filter presses, water filters, conveyor belts for truck loading, a field office, and limited construction personnel parking (no more than 6 spaces for Resident Engineer, Inspectors, Management personnel). All work will be conducted from the staging area. Truck queuing will take place off-site.

Staging area runoff will be contained by the use of silt fences and hay bales (see Figure 7-3). The Contractor will be required to provide a stabilized entrance to the staging area equipped with a wheel wash in order to prevent tracking of soil and dust onto local streets. Water from the wheel wash will be detained in a sedimentation tank for settling before being discharged to the Muddy River. Regular street sweeping and other construction Best Management Practices (BMPs), such as use of calcium chloride for dust control, will also be required to control runoff from construction areas. The condition of the erosion controls and the streets will be inspected and documented daily.

Prior to final approval of the Charlesgate work by the Department of Environmental Protection (DEP) and the Boston Conservation Commission (BCC), the Contractor will be required to submit a Stormwater/Dewatering Pollution Prevention Plan (S/DPPP). The S/DPPP will contain an Erosion and Sedimentation Control Plan and a Spill Prevention Control, Containment and Countermeasure Plan that would be specific and applicable to each staging area. These plans will state the Contractor's intent for managing site runoff, monitoring, and maintenance.

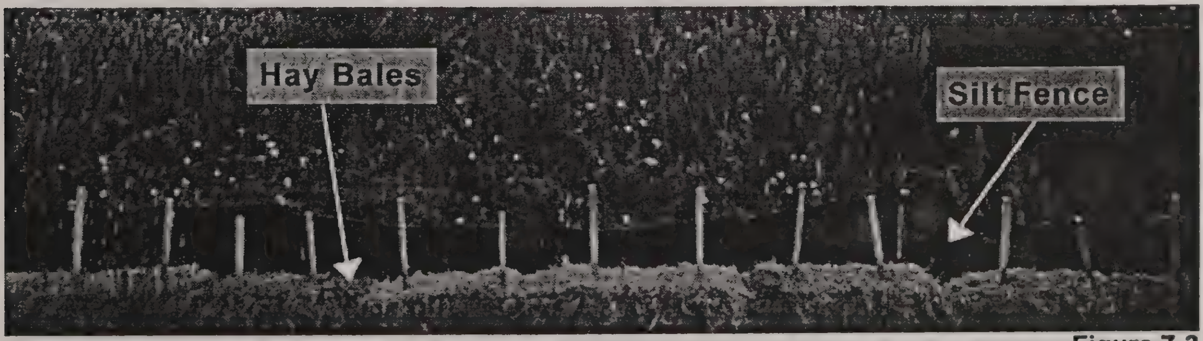


Figure 7-3
Hay Bales and Silt Fencing

As soon as the work in the staging area is completed, the site will be restored and re-vegetated as shown in the Preliminary Design Report (see Appendix I). During restoration, erosion control measures will be maintained as removal of work surface could lead to additional erosion.

Weekly Environmental Inspection Reports that contain the results of the inspections, the progress of the work, anticipated work for the following week, the results of water quality monitoring (see Section 7.2.3), and other pertinent details will be submitted to the proponents, DEP, ACOE (if requested), and Boston Conservation Commission.

On an as-needed basis, site walks with representatives of DEP, the ACOE (if involved), and the Conservation Commission will take place to review site conditions.

7.2.3 Construction Period Water Quality Monitoring

The potential for short-term water quality impacts will be present wherever dredging and earthwork is undertaken. In order to be able to take appropriate measures to minimize unanticipated water quality disturbance, monitoring of the Muddy River will continue through all phases of construction, plus two years following the stabilization of the restored ground and banks. The construction period water monitoring will be the Muddy River Water Quality Monitoring Program that will take place before, during, and after construction has been completed (see Appendix G - Water Quality and Section 8.0 - Management and Maintenance Plan).

The construction-period water quality monitoring will include the following:

1. Continuous monitoring of suspended solids with appropriate meters 200 feet upstream and 500 feet downstream of the dredging/earthwork operations.

2. Weekly monitoring of all discharges from sedimentation tanks, dredged material dewatering equipment, and the Muddy River upstream and downstream of the dredging operation(s).

3. The weekly water samples will be collected and analyzed for:

   Temperature (field)
   Dissolved Oxygen (field)
   pH (field)
   Total Petroleum Hydrocarbons (lab)
   Total Lead (lab)
   Dissolved Lead (lab)

4. The monitoring results will be attached to a weekly Environmental Inspection Report (see S/DPPP) that is prepared by the IEM and submitted to the proponent, DEP, and the Boston Conservation Commission,

7.2.4 Parkland Monitoring

To ensure that the Contractor's activities and equipment remain within the allowed construction limits, the final design plans will contain specifically marked limits of construction. These limits of construction will be prepared by the engineer and landscape architect and will be placed such that the necessary entry into parkland does not adversely impact sensitive vegetation, heritage trees and historic features, nor lead to adverse water quality impacts. During construction, the IEM will monitor the Contractor's activities to ensure that the work remains within the designated limits of construction.

7.2.5 Traffic Control During Construction

The following traffic related mitigation is proposed:

- Equipment mobilization to/from the staging area will require police supervision as a safety precaution. For trucks entering and exiting the staging area, where a sidewalk crossing occurs, the contractor will be required to provide a ground guide.

- Contractors must be required to follow the truck haul routes designated in Appendix I. This will minimize truck traffic on residential roadways not appropriate for truck traffic.

- Truck queuing will not be allowed on local roads and side streets. The Contractor will provide for an off-site truck queuing location and radio control.

- The City of Boston's ordinance regarding idling of truck engines will be enforced.

- All sidewalks and paths will be fully restored once construction activity has ended.

- Limited contractor parking (no more than 6 spaces for Resident Engineer, Inspectors, Management personnel) will be provided either within the bounds of an active staging area or off-site (at a location to be determined). At no time will contractor(s) be allowed to block a travel lane with parking. An employee carpooling plan will be strongly encouraged, whereby only one or two contractor vehicles are parked within the staging area and other vehicles are off-site.

7.2.6 Restoration of the Construction Site

Upon completion of work at any location within the Charlesgate Area, the Contractor shall clear the site of all construction equipment, security fencing and other appurtenances, except silt and hale bay fencing. The Contractor shall restore any disturbed silt fences and hay bale fencing, re-seed, and revegetate the site as directed in the design plans and specifications. In the event that a construction site is closed during the winter and revegetation is not possible, the site shall be mulched to minimize erosion. Such sites will be revegetated in the earliest part of the following growing season. The IEM will monitor the implementation of the restoration activities and will include the progress of this work in the Weekly Environmental Inspection Reports. The inspection reports will be distributed to the Project Proponent, the Resident Engineer, the Conservation Commission(s) and the DEP. The Contractor will be responsible for the successful restoration of the site(s) and for success of replanting for a two-year period after the completion of all construction. Enforcement of the conditions and requirements of the permits and approvals/ specifications will be the responsibility of the Project Proponents through the Resident Engineer. The Conservation Commission(s) may also choose to inspect construction sites.

7.2.7 Charlesgate Area Draft Section 61 Findings

As decreed by the Secretary, draft findings pursuant to M.G.L. Chapter 30, Section 61, are presented herein. This statute requires state agencies, which permit or fund projects for which an Environmental Impact Review is conducted under MEPA, to make certain "findings" with respect to how detrimental impacts of the project have been avoided, minimized and mitigated. The findings must reflect the information disclosed through MEPA documentation and must relate to the subject matter jurisdiction of the permitting agency. Thus, the state permits to be issued by the Department of Environmental Protection for dredging and for water quality certification at Charlesgate required the DEP to issue Section 61 findings. The following contains proposed findings for consideration by the DEP.

DRAFT

MASSACHUSETTS DEPARTMENT OF ENVIRONMENTAL PROTECTION FINDINGS PURSUANT TO M.G.L. CHAPTER 30, SECTION 61

PROJECT NAME:	**The Phase I Muddy River Flood Control, Water Quality and Wildlife Enhancement and Historic Preservation Project** **Charlesgate Area**
PROJECT LOCATION:	**Boston, MA**
PROJECT PROPONENT:	**Boston Parks and Recreation Department; Town of Brookline, MA**
EOEA NUMBER:	**11865**

BACKGROUND

In the Charlesgate section of the Muddy River, flooding results from inadequate cross-sectional area of the river caused by sedimentation and from obstructions in the flow channel and under bridges. Correcting these deficiencies will result in flood control benefits and water quality improvements.

PROJECT DESCRIPTION

Construction activities that are proposed within the Charlesgate Area include:

- The formation of one staging area for dredging equipment including belt filter presses and other appurtenances,
- The removal of waterway obstructions,
- The dredging and removal of approximately 3,300 cubic yards (cy) of accumulated sediment and debris,
- The restoration and re-vegetation of the staging area upon completion of the work,
- The planting of new vegetation,
- The repair or replacement of worn pathways, and
- Installation of new park benches.

The proposed construction and revegetation activities are shown in the Preliminary Design Report that is included in Appendix I of the Draft Environmental Impact Report (DEIR).

PROJECT IMPACTS

A detailed analysis of Charlesgate Area impacts was provided in Section 6 of the DEIR. Generally, the long-term impacts of the project will be beneficial, resulting in:

- Improved flood control
- Improved water quality
- Enhanced biological environment

Short-term impacts during the construction period will include the following:

- Temporary water quality impacts from the staging area, from dredge and debris removal locations, and from the return water.
- Temporary impact to vegetation at the staging area and adjacent to the river.
- Temporary impact to the limited aquatic and wildlife resources which exist.
- Temporary impact on recreational use and pedestrian access.

MITIGATION MEASURES

In accordance with the above Section 6 of the DEIR, required mitigation for Charlesgate Area activities are associated with controlling runoff from the staging area, minimizing turbidity and suspended solids during dredging, and traffic management during construction. The DEIR describes several plans and initiatives intended to address these short-term impacts. They include:

- The use of an Independent Environmental Monitor to review and inspect all mitigation measures and data, to submit weekly BMP Inspection Reports, and to conduct inspections with the Boston Conservation Commission, the DEP, the ACOE, and other agencies as necessary.
- Specifications for a Dredge Material Management Plan (DMMP) required by the selected contractors.
- Designation of an Independent Environmental Monitor (IEM) to oversee the contractors' work and ensure compliance with the DMMP.
- Installation of a silt curtain and one absorbent boom as needed to prevent the spread of turbid water into the Charles River.
- Use of hay bales and silt fences to contain staging area runoff.
- Use of wheel washing equipment at the staging area to minimize sediment transport.
- Street Sweeping and Dust Control

- Development of a Stormwater Pollution Prevention Plan to contain an Erosion and Sedimentation Control Plan and a Spill Prevention Control, Containment and Countermeasures Plan.

- Landscape restoration measures that are consistent with the Preliminary Design Report in Appendix I, and the inspection of the Contractor's activities within the Parkland.

- Odor Control

- Water quality monitoring during construction that includes:

    1. Continual monitoring of suspended solids with appropriate meters 200 feet upstream and 500 feet downstream of the dredging/earthwork operations,

    2. Weekly monitoring of all discharges from sedimentation tanks, dredged material dewatering equipment, and the Muddy River upstream and downstream of the dredging operation(s).

    3. Water samples will be collected and analyzed for:

        Temperature (field test)
        Dissolved Oxygen (field test)
        pH (field test)
        Total Petroleum Hydrocarbons (laboratory test)
        Total Lead (laboratory test)
        Dissolved Lead (laboratory test)

    4. The monitoring results will be attached to a weekly BMP Inspection Report (see Stormwater Pollution Prevention Program) that is submitted to the DEP and the Boston Conservation Commission,

    5. Site walks with representatives of the DEP, the ACOE, and the Conservation Commission on as needed basis.

- Traffic control measures as follows:

    1. Equipment mobilization to/from the staging area will require police supervision as a safety precaution. For trucks entering and exiting the staging area where a sidewalk crossing occurs, the contractor will be required to provide a ground guide.

    2. Contractors must be required to follow the truck haul routes designated Appendix I. This will help minimize truck traffic on residential roadways not appropriate for truck traffic.

3. All sidewalks and paths will be fully restored once construction activity has ended.

4. Limited contractor parking (no more than 6 spaces for Resident Engineer, Inspectors, Management personnel) will be provided either within the bounds of an active staging area or off-site (at a location to be determined). At no time will contractors be allowed to block a travel lane for parking. A carpooling plan is strongly encouraged, whereby only one or two contractor vehicles are parked within the staging area and other vehicles are off-site.

FINDINGS

For the reasons stated above, DEP hereby finds that, with implementation of the mitigation measures described above by the City of Boston, all practicable means and measures will be taken to avoid, minimize, and mitigate sewage related impacts to the environment resulting from the Proposed Phase I Muddy River Flood Control, Water Quality and Wildlife Enhancement and Historic Preservation Project. Appropriate conditions will be included in the Chapter 91 permit and Water Quality Certification to be issued by DEP to describe more fully and ensure implementation of said measures.

____________________ ______________________________________
Date Appropriate Signature

7.3 Environmental Mitigation for Construction Activities from the Back Bay Fens Through Wards Pond

The construction activities will include dredging (see Figure 7-4), daylighting, culvert enlargement and replacement, shoreline stabilization, the placement of muck soil for the establishment of wetland and shoreline plantings and the planting of the wetland, shoreline and upland vegetation, the restoration of historic islands, and other activities for the preservation of historic features of the Emerald Necklace. The following plans will be submitted by the Contractor, and reviewed and accepted.

- Dredged Materials Management Plan
- Stormwater/Dewatering Pollution Prevention Plan
- Construction-Period Water Quality Monitoring Plan
- Plan for Monitoring of Wetland, Shoreline and Landscape Restoration
- Rodent Control Plan
- Plan for the Monitoring of the Three-Spine Stickleback
- Public Outreach Program

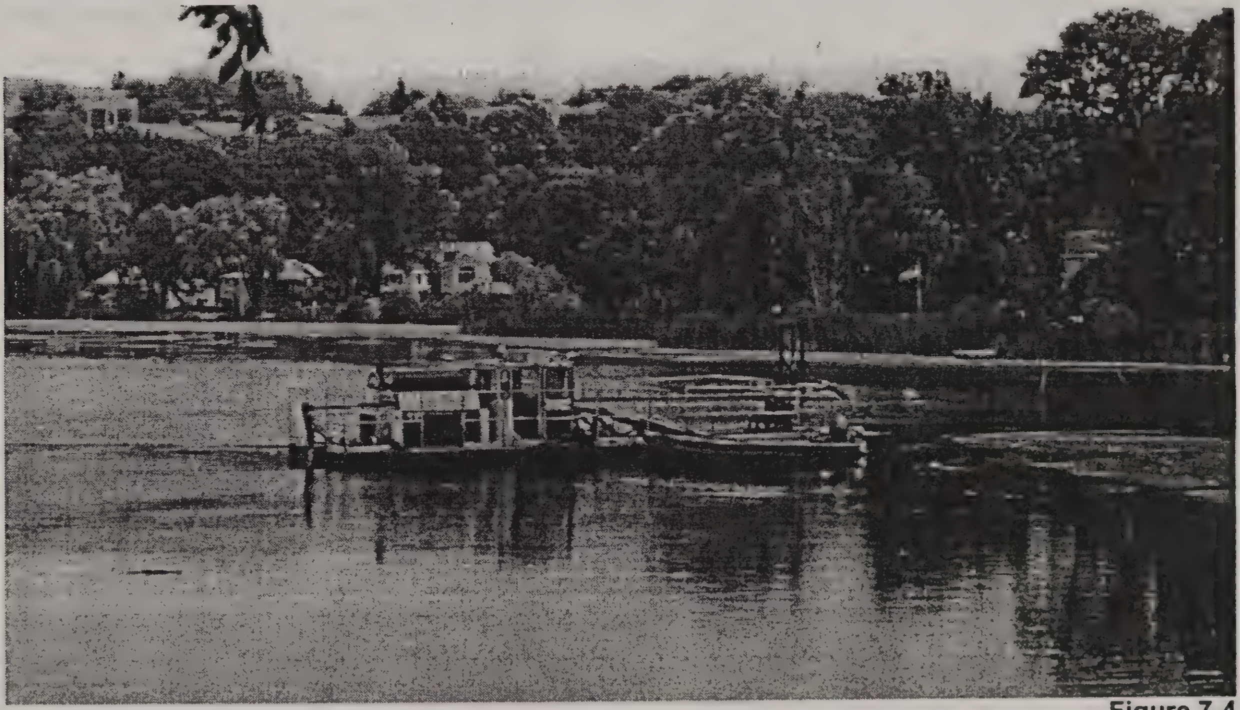


Figure 7-4
Mud Cat Dredge at Hardy Pond, Waltham, MA

7.3.1 Dredged Materials Management Plan

The sediments to be dredged have been characterized to determine the appropriate management activities for their removal from the Muddy River, dewatering, and ultimate disposal. The quality of the sediment varies. In some locations, and within short distances, sediment that meets the DEP's unlined landfill criteria can be adjacent to TCLP toxic sediments. Each of these conditions requires different management actions. Therefore, in order that the Contractor state its plans for the proper management of such materials, the Contractor will be required to submit a Dredged Materials Management Plan (DMMP). The DMMP will be the Contractor's commitment for environmental compliance. The DMMP will contain the following information:

- Project Objectives
- Existing Sediment Quality
- Existing Water Quality
- Existing Aquatic, Wetland, and Upland Biological Resources
- Historical and Architectural Resources
- Structural and Geographic Limitations to Dredging, Equipment, and Materials Management
- Dredged Materials Management
  - Proposed Dredging Methods
    - Hydraulic
    - Excavator
    - Dredging Equipment and Performance Criteria
    - Compatibility of the Dredging Equipment With the Disposal Methodology
  - Dredging Sequence
  - Dewatering and Sediment Stabilization
  - Water Quality Mitigation Measures During Removal of the *Phragmites* Root Mass and Hydraulic Dredging, Siltation Control
- Upland Support Requirements, Staging Areas
- Operational Controls
  - Traffic Management
  - Truck Queuing and Engine Idling Restrictions
- Pedestrian Movement
- Trash and Debris Removal
- Noise Control
- Dust Control
- Odor Control
- Repair of Damaged Landscaping and Vegetation
- Schedule
- Mobilization
- Regulatory Requirements
- Water Quality Monitoring
- Parkland Monitoring
- Contingency Plan In the Event That Uncontrollable Environmental Problems Occur
- Emergency Response Plan and a Spill Prevention Control Containment and Countermeasure Plan (Title 29 CFR 1910.120 of OSHA Standards, 40 CFR 112, FEMA Emergency Plan Requirements, Section 105 of CERCLA, Massachusetts Right-to-Know Act and other local, state and federal requirements, as appropriate).

At space-limited locations where dredging with excavators will be necessary, the area will be enclosed with a silt curtain to prevent the downstream spread of turbid water and potentially into the Charles River. A silt curtain will also be maintained at the conduit under Storrow Drive to prevent floating debris and sheens from entering the Charles River. Oil absorbent materials will be maintained at the booms. The silt curtain and absorbent materials will be inspected daily. Accumulated debris and trash will be removed daily and the absorbent pads will be replaced as needed.

The DMMP will be submitted by the Contractor for review and acceptance.

7.3.2 Stormwater/Dewatering Pollution Prevention Plan

It is anticipated that the Contractor will form staging areas by placing a moderately dense layer of gravel and stone over the existing ground. As such, the underlying soil will remain essentially undisturbed and will not be subject to erosion. Each staging area for dredging will contain sedimentation tanks, pumps, coagulant polymer feed systems, belt filter presses (see Figure 7-5), water filters, conveyor belts for truck loading (see Figure 7-6), a field office, and limited construction personnel parking (no more than 6 spaces for Resident Engineer, Inspectors, Contractors, and Management personnel). Staging areas not used for dredging will include trailers and materials staging for contractor's work. All work will be conducted from the staging areas. Truck queuing will take place off-site. More intense typical construction activities will occur at the Fens Bridge and former Sears parking lot sites due to the large amount of excavation, rip-rapping, grading, and plantings that are necessary for the daylighting and culvert enlargement. In addition, at the former Sears parking lot, piles will have to be driven to form the foundation for the arch culvert.

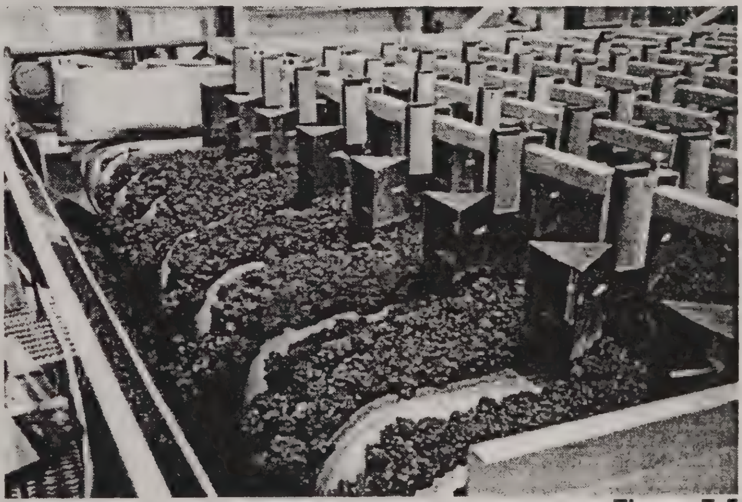


Figure 7-5
Belt Filter Press at Hardy Pond, MA

The staging area runoff will be contained by the use of silt fences and hay bales. The Contractor will be required to provide a stabilized entrance to the staging area equipped with a wheel wash in order to prevent tracking of soil and dust onto local streets. Water from the wheel wash will be detained in a sedimentation tank for settling before being discharged to the Muddy River. Regular street sweeping and other Construction BMPs (such as use of calcium chloride to reduce dust) also will be required to control runoff from construction areas. The condition of the erosion controls and the streets will be inspected and documented daily.

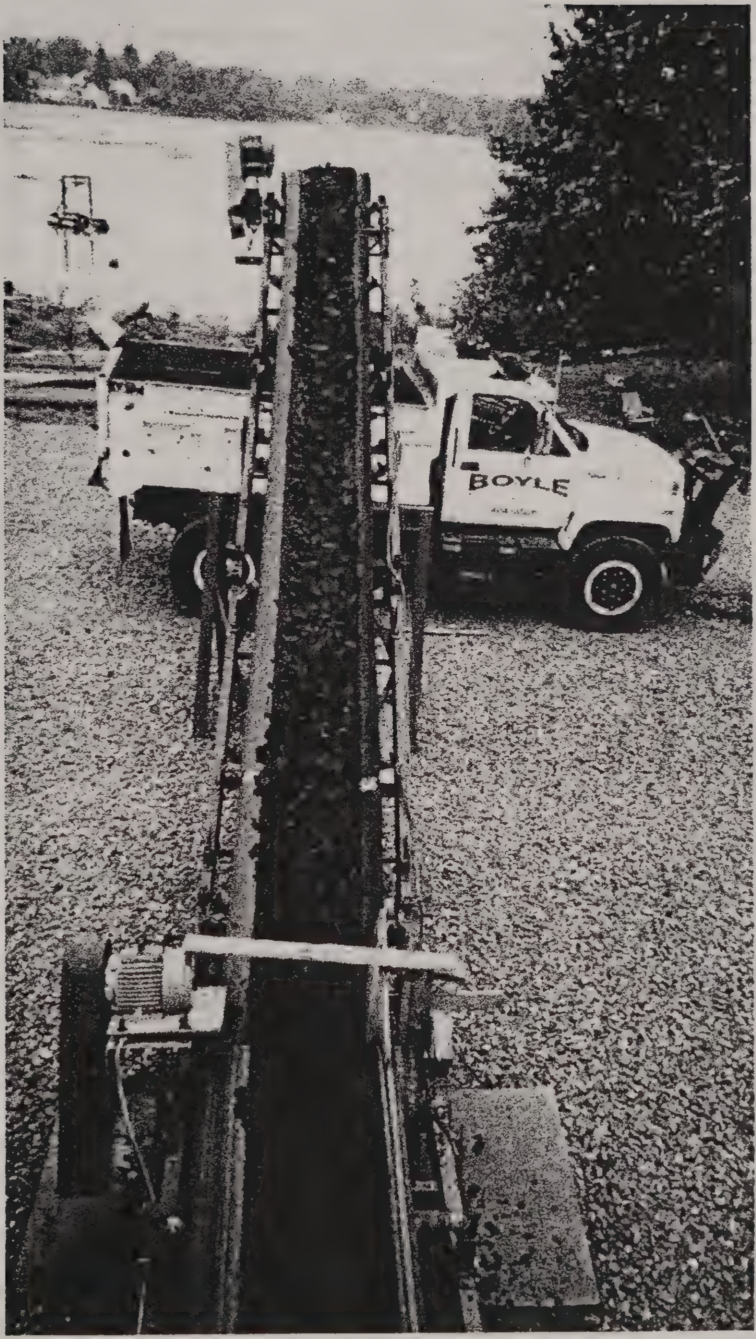


Figure 7-6
Dewatered Filter "Cake" Being Loaded
at Hardy Pond, Waltham, MA

Prior to final approval by the Department of Environmental Protection (DEP) and the Boston Conservation Commission (BCC), the Contractor will be required to submit a Stormwater/Dewatering Pollution Prevention Plan (S/DPPP). The S/DPPP will contain an Erosion and Sedimentation Control Plan and a Spill Prevention Control, Containment and Countermeasure Plan that would be specific and applicable to each staging area. These plans will state the Contractor's intent for managing site runoff, monitoring, and maintenance.

As soon as the work in the section of the Muddy River being served by a staging area is completed, the site will be restored and revegetated as shown in the Preliminary Design Report (see Appendix I). During restoration, erosion control measures will be maintained as removal of work surface could lead to additional erosion.

Weekly Environmental Inspection Reports that contain the results of the site inspections, the progress of the work, anticipated work for the following week, the results of water quality monitoring (see Section 7.2.3), and other pertinent details will be submitted to the proponents, DEP, ACOE (if involved), and both Conservation Commissions.

On an as-needed basis, site walks with representatives of DEP, ACOE (if involved), and both Conservation Commissions will take place to review on ground conditions.

7.3.3 Construction Period Water Quality Monitoring

The potential for short-term water quality impacts will be present wherever dredging and earthwork is undertaken. In order to be able to take appropriate measures to minimize unanticipated water quality disturbance, monitoring of the Muddy River will continue through all phases of construction, plus two years following the stabilization of the restored ground and banks. The construction period water monitoring will be in addition to the Muddy River Water Quality Monitoring Program that will take place before, during, and after construction has been completed. (see Section 8.0 - Management and Maintenance Plan).

Construction water quality monitoring will include the following:

1. Continuous monitoring of suspended solids with appropriate meters, 200 feet upstream and 500 feet downstream of the dredging/earthwork operations,

2. Weekly monitoring of all discharges from sedimentation tanks, dredged material dewatering equipment, and the Muddy River upstream and downstream of the dredging operation(s). Water samples will be collected and analyzed for:

   Temperature (field test)
   Dissolved Oxygen (field test)
   pH (field test)
   Total Petroleum Hydrocarbons (laboratory test)

Total Lead (laboratory test)
Dissolved Lead (laboratory test)

3. The monitoring results will be attached to a weekly BMP Inspection Report (see S/DPPP) that is submitted to the DEP and the Boston and Brookline Conservation Commissions.

7.3.4 Parkland Monitoring

To ensure that the Contractor's activities and equipment remain within the allowed construction limits, the final design plans will contain specifically marked limits of construction. These limits of construction will be prepared by the engineer and landscape architect and will be placed such that the necessary entry into parkland does not adversely impact sensitive vegetation, heritage trees and historic features, nor lead to adverse water quality impacts. During construction, the IEM will monitor the Contractor's activities to ensure that the work remains within the designated limits of construction.

7.3.5 Plan for the Monitoring of Wetland, Shoreline, and Landscape Restoration

The purpose of the Plan for the Monitoring of Wetland, Shoreline, and Landscape Restoration is to ensure the rapid discovery of developing concerns, whether it is erosion or die-off of vegetation, and the equally rapid correction. The Contractor will be responsible for the restoration of all disturbed areas including, but not limited to, staging areas, access points, shorelines, and other areas that were disturbed by construction and restoration activities. The Contractor will provide a qualified horticulturist/arborist, and Certified Wetland Scientist to conduct weekly inspections during construction progress of the bank stabilization and the planting of wetland, shoreline and upland vegetation. The inspections will be conducted with the Resident Engineer or designee. Inspections may also be conducted with the DEP, and the Conservation Commissions as required. Noted exceptions and areas of concern will be corrected within one week, or sooner if the Resident Engineer deems such. Within two days of each inspection, the Contractor will provide Inspection Reports, which contain maps of the plant beds, field notes and logs describing the corrective measures that were taken, if any, and quantities of materials that were used, as well as locations where they were applied. The Contractor will provide a two-year guarantee for the success of the soil stabilization and all plantings.

7.3.6 Rodent Control

The stands of *Phragmites* and adjacent areas (i.e. the Victory Gardens, Boston Emergency Management Office) contain rats, muskrats and other rodents. In order to prevent the displacement of rodents to adjacent areas where they may become a nuisance to park users and area residences, the Contractor will conduct a program to control rodents within the Project Limits. The Contractor will conduct the rodent control program in a cooperative manner with the interests groups that operate within the Emerald Necklace Parks, i.e. the Victory Gardens, the Inspectional Services

Department, Public Health Department, the Environment Department. Positive steps will be taken to ensure the safety of pets from the baits. The Contractor will employ a pest control supervisor who is licensed and certified by the Massachusetts Pesticide Bureau in General Pest Control (Category 41) and Vertebrate Pest Control (Category 44). Weekly inspection/survey reports will be filed with the Resident Engineer showing locations of bait stations, the amount of bait used, conclusions and recommendations.

7.3.7 Public Outreach Program

Throughout the course of the construction period there will be a regular outreach program in order to keep abutters informed of the progress of the work as well as the upcoming schedule. Public Meetings will be held regularly to allow for the opportunity for discussing issues during, and following, the construction period. The meetings will also allow for the opportunity for the expression of problems and/or concerns during, and following, the construction period. The Resident Engineer will provide regular, and timely, updates to the proponent for release to the local media.

The project also plans to provide descriptive boards and signage describing the project and the ongoing work as part of the program to keep the public informed.

7.3.8 Traffic Control During Construction

The following traffic- related mitigation is proposed:

- Equipment mobilization to/from the staging areas and the areas of culvert construction will require police supervision as a safety precaution. For trucks entering and exiting the staging area where a sidewalk crossing occurs, the contractor will be required to provide a ground guide.

- Culvert construction across The Riverway will require lane closures and will be restricted to no more than one-lane closures at a time. Signal timing adjustments will be needed at several intersections through the Sears Rotary as a result of these lane closures.

- When construction of the Brookline Avenue culvert (at former Sears parking lot) is within the existing traveled way, lane closures cannot occur during daylight, so work will take place at night. Night work will allow lane closure and/or construction of temporary lanes to expedite work. Contractor will be required to replace a bridging slab over the roadway so all lanes in the traveled way will reopen during the day.

- Work at the Brookline Avenue culvert will be considered for daylight weekend work during lower traffic times except when it conflicts with baseball games or major institution functions in the area that would generate excess weekend traffic.

- Contractors must be required to follow the truck haul routes designated on Figure 6-10 and Appendix I. This will help minimize truck traffic on residential roadways not appropriate for truck traffic.
- Truck queuing will not be allowed on local roads and side streets. The Contractor will provide for an off-site truck queuing location and radio control.
- The City of Boston's ordinance regarding idling of truck engines will be enforced.
- All sidewalks and paths will be fully restored once construction activity has ended.
- Limited contractor parking (no more than 6 spaces for Resident Engineer, Inspectors, Management personnel) will be provided either within the bounds of an active staging area or off-site (at a location to be determined). At no time will contractors be allowed to block a travel lane for parking. A carpooling plan is strongly encouraged, whereby only one or two contractor vehicles are parked within the staging area and other vehicles are off-site.
- Pedestrian access on Netherlands Road and Agassiz Road will be maintained while these roads are temporarily closed and used as staging areas for construction equipment.
- At the intersection of The Riverway at Brookline Avenue, there are existing capacity deficiencies that are expected to be exacerbated while Netherlands Road is closed and used as a staging area. The predominant level-of-service and delay degradation is expected to occur to the left-turning movements from Brookline Avenue onto The Riverway. The following mitigation should be considered to alleviate these impacts
- Redesignate The Riverway northbound at Brookline Avenue approach right-turn only lane as a shared through/right-turn lane. This will require modification to the signal phasing.
- Consider upgrading the traffic signal equipment and providing an exclusive left-turn phase for both eastbound and westbound traffic on Brookline Avenue (currently, the westbound approach has a short lead phase).
- The Resident Engineer will regularly coordinate with other local projects which impact traffic such as Fenway Park, MASCO, Emmanuel College, etc.

7.3.9 Habitat Protection, Mitigation, and Enhancement for the Three Spine Stickleback

As discussed in Section 4.6.2.3, the three spine stickleback, a threatened species of fish listed by the Massachusetts Natural Heritage Program, inhabits Spring Pond which is a small tributary to Willow Pond. A one and one-half to two foot high stone dam that is in need of repair, separates Spring Pond from Willow Pond. Spring Pond is kept considerably cooler than Willow Pond by the discharge of groundwater into the Spring Pond. Willow Pond also has watercress and a small amount of filamentous algae growing in it.

The proposed project elements at Willow Pond were discussed with the Natural Heritage Program staff, reviewed in the field and further discussed in telephone conversations. Through these and other efforts, opportunities were observed where the habitat conditions for the three spine stickleback can be protected, as well as, enhanced. The Natural Heritage Program requested that a habitat protection, mitigation and enhancement effort be conducted. The protection, mitigation, and enhancement effort which will be conducted by the Contractor, will be coordinated with the Natural Heritage Program staff and includes the following:

- Control of sedimentation that is entering Spring Pond from the adjacent bank and pathways,
- Careful removal of debris and leaf litter from Spring Pond,
- Dredging contaminated sediment from Willow Pond including the small stickleback-inhabited pool below the stone dam,
- Reconstruction of the stone dam between Willow Pond and Spring Pond, and
- Restoration of the small pool including water cress and shade plantings for sticklebacks to inhabit.

The overall Muddy River Restoration Project will be conducted as a limited project under the DEP environmental regulations. Under the definition of a limited project, the project should have no impact on threatened or endangered species. The mitigation measures discussed for Spring Pond, and at the entrance of Spring Pond's runoff into Willow Pond, were in response to an opportunity identified by the Natural Heritage Program staff to improve the habitat for the three-spined stickleback, a threatened species. In order to maintain the project as a limited project, activities would not have been proposed in the Spring Pond area without the advocacy of the Natural Heritage Program. It is critical to the overall schedule that the project not be subject to the variance procedure, which is time consuming, project support and funding.

During the comment period on the DEIR, regulatory agencies should review the proposed mitigation measures and whether the proposed improvements are likely to initiate the need for a variance. In the view of the project proponents, the mitigation measures at Spring Pond suggested by the Natural Heritage Program staff are beneficial to the project and the threatened species and, therefore must be viewed as a positive aspect of the project. These beneficial impacts of the project would be squandered if the project were subject to a variance and, therefore in all likelihood, the mitigation opportunity would be lost.

7.3.9.1 Control of Sedimentation into Spring Pond

In an effort to protect Spring Pond from sediment entering the pond from adjacent bank and pathways, a concerted effort will be made to employ strict erosion control techniques during construction. Silt fences and hay bales will be used to protect Spring Pond from sediment eroding from the paths and roadways that may be used during the construction period. The Independent Environmental Monitor will make daily inspections of this sensitive area and any damage to the erosion control structures must be repaired before work in adjacent areas can continue.

A piece of the Daisy Field drain operated by the BWSC collapsed resulting in considerable debris and erosion occurring in the general vicinity of Spring Pond. This situation has been corrected by BWSC, however, the IEM should inspect the area monthly and after rainstorms to verify that no more impacts from this drain are affecting Spring Pond. If the IEM notices impacts, then BPRD and BWSC will be notified.

7.3.9.2 Careful Removal of Debris and Leaf Litter from Spring Pond

A large threat to the survival of Spring Pond as an open water body is derived from leaves as well as sedimentation. In order to reduce the rate of ecological succession in the Pond, it is recommended that leaves branches and debris be carefully removed. Because this work could cause damage to the habitat and the sticklebacks, the work should be conducted under the direct supervision of an approved (Natural Heritage Program) expert in stickleback biology.

7.3.9.3 Mitigation to Protect the Habitat of the Three Spined Stickleback During Dredging of Willow Pond

Willow Pond was reported to have been dredged to 7.5 feet in 1963 (see Section 4.6). At the present time there are considerable sediment deposits and bars which result in an average water depth of one foot or less. The sediment in Willow Pond is also heavily contaminated with petroleum hydrocarbons from upstream sources. Therefore, in order to enhance the aquatic and wetland habitat and return the Willow Pond to its historic proportions, it is necessary that the sediment deposits be dredged from Willow Pond including those in the small pool of water below the stone dam at the Spring Pond outlet.

In order to accomplish the dredging and protect the sticklebacks, the following mitigation measures are recommended:

- Place two screens in the outlet from Spring Pond to prevent sticklebacks from leaving the Pond,
- Trap and remove the sticklebacks from the pool in Willow Pond and relocate them to Spring Pond,
- Dredge Willow Pond and re-construct the stone dam WITHOUT the loss of water level in Spring Pond,

- Replace the pool below the stone dam in Willow Pond by using clean, clay-free gravel,
- Plant shoreline and wetland vegetation in the immediate area of Willow Pond and revegetate the pool with watercress, and
- Remove the screens in the Spring Pond outlet after all reconstruction is completed.

7.3.10 Noise Mitigation at Brookline Avenue Culvert

Construction of the culvert under Brookline Avenue near the former Sears parking lot will include a combination of day and nighttime work due the difficult traffic conditions at the Sears Rotary. As described in Section 5 work on either end of the culvert can be constructed using normal day time construction period since there is sufficient room in adjacent park areas for mobilization and work areas. When constructing the across the Brookline Avenue, constructing new temporary lanes for traffic will result in significant traffic impacts unless done at night time.

In order to mitigate noise impacts on residences in the area the following noise mitigation measures will be undertaken:

- Regulation for the Control of Noise in the City of Boston will be followed for construction activities. This regulation would restrict noise to 65 dBA (decibels) in the business zone at all times except for the operation of certain construction equipment which is limited to an L10 value of 80 dBA.
- Noise measurements, using appropriate field sound equipment will be carried out by the contractor on a weekly basis. The IEM will be provided these results and may request to witness the measurements. Should noise levels exceed the allowed limit measured at locations indicated in the regulations, the contractor will take steps as necessary to reduce noise to levels acceptable to the Resident Engineer and responsible municipal officials.
- All construction equipment will be fitted with suitable mufflers and similar noise abatement devices prior to receiving approval to commence work.

Installation of foundation piles will be required to use drilled piling techniques to reduce noise levels. Sheet piling will use vibrating driving equipment to reduce noise levels. Foundation piles and sheet piling work will be limited to 11:00 PM or work on weekends when traffic impacts are reduced and work can be accomplished during daytime hours.

8

Section
Eight

Section 8
Management and Maintenance Plan

8.1 Introduction

The Emerald Necklace is the historic core of the Boston and Brookline park system. It consists of a series of linked parks of nearly 1,000 acres, a significant amount of parkland in Boston and Brookline (see Figure 8-1). Designed over 100 years ago by Frederick Law Olmsted, it was intended as a refuge from the city and a place where people from all walks of life could come together for recreation and relaxation at the end of the day. The park system forms the border between Boston and Brookline with each municipality responsible for its own lands. The MDC owns the Charlesgate section of the Back Bay Fens and is responsible for the care, custody, and control of the parkways and parkland located 25 feet in from the curb.

The 1990 Emerald Necklace Parks Master Plan (Executive Office of Environmental Affairs, Department of Environmental Management, City of Boston, Town of Brookline; published in April 2001) provides a long-range vision and an outline for the future. The Master Plan identifies a broad range of environmental, historic, and capital improvements, many of which have been completed over the past 10 years.

The implementation of these improvements began in the late 1980s, even before the draft Master plan was completed. In 1999, the signing of a Memorandum of Understanding (MOU) established a tripartite State, City and Town partnership to pursue the Muddy River Restoration Project. The MOU signatories include:

- Executive Office of Environmental Affairs;
- Department of Environmental Management;
- Massachusetts Emergency Management Agency;
- Boston Water and Sewer Commission;
- Boston Parks and Recreation Department;
- City of Boston; and
- Town of Brookline.

The implementation of the MOU began in June 1999 with the start of work on the Environmental Impact Report (EIR) for the Muddy River Flood Control, Water Quality and Habitat Enhancement, and Historic Restoration Project. The Certificate from the Secretary of Environmental Affairs for the Project contained a number of specific requirements including:

- The completion of an Environmental Impact Report (EIR) for the proposed work;

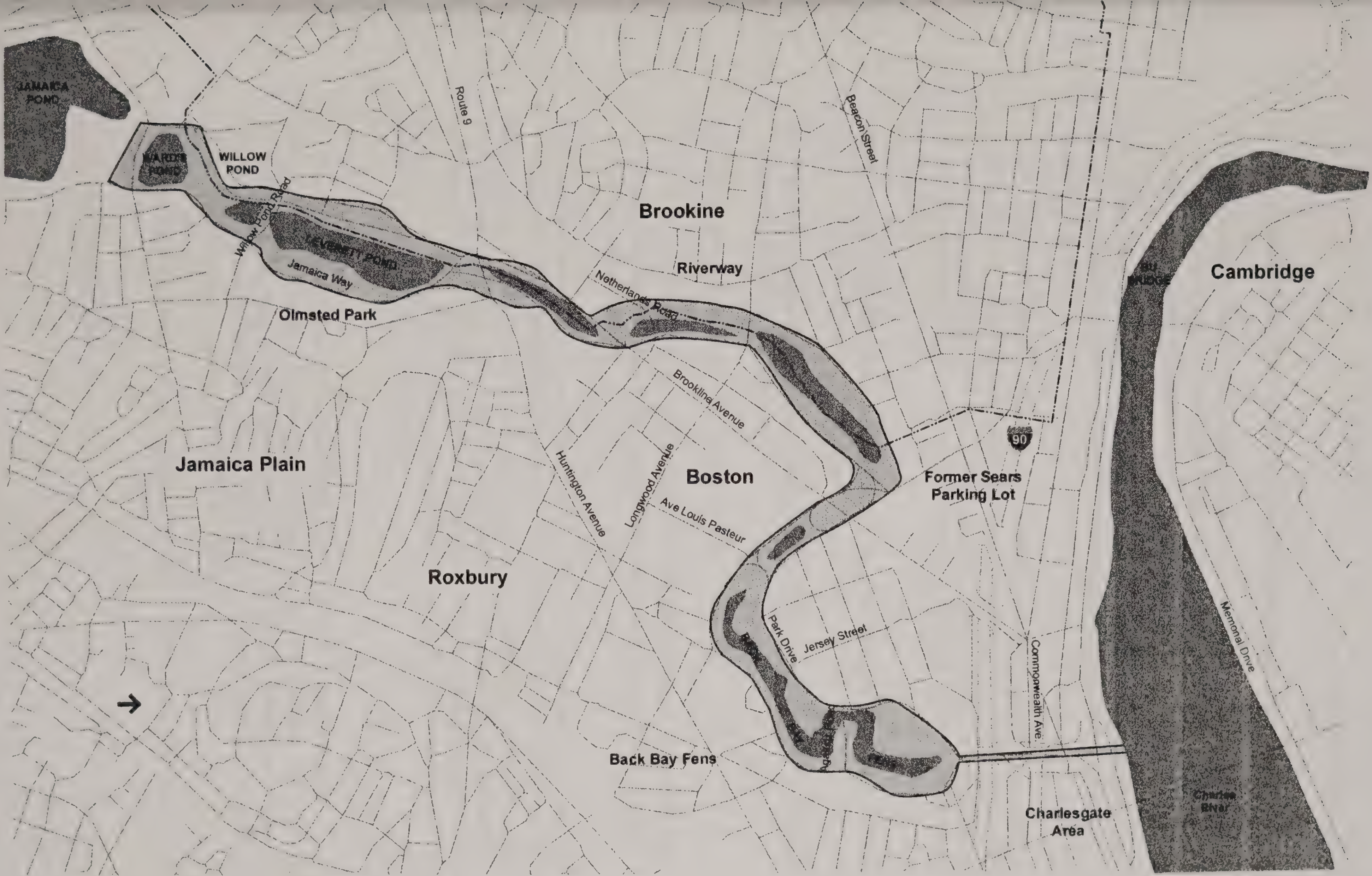


Figure 8-1
Phase 1 Project Area
Source: CDM

- The preparation and implementation of a Management and Maintenance Plan; and
- The submittal of an Annual Update to the Secretary of Environmental Affairs in which the accomplishments of the previous year, deferred work, omissions, problems, and forthcoming plans are reported.

The Management and Maintenance Plan is intended for the following groups, all of whom have an opportunity to contribute to its preparation, updating, and implementation:

1. The Executive Office of Environmental Affairs and state agencies to receive specific feed-back from the City of Boston, the Town of Brookline, and the MDC on the implementation of the Management and Maintenance Plan and to ensure that there is compliance with the permits and approvals that have been issued for the Project;
2. The City of Boston, Parks and Recreation Department with support from BWSC and Boston Public Works Department;
3. The Town of Brookline, Parks and Open Space with support from Brookline Department of Public Works;
4. The Metropolitan District Commission; and
5. Park partners and private parties and other stakeholders including interested institutions, businesses, individuals and organizations, such as the Emerald Necklace Conservancy.

Each of the above interests are encouraged to develop a better understanding of the overall maintenance operations, schedules, and priorities and they are provided an opportunity to work in concert, clarify issues, identify and solve problems, develop strategies for obtaining new resources, and improve communications. While the municipalities and the MDC will shoulder the preponderance of the maintenance of the improvements, the private sector is expected to contribute to abutting landscapes that will in turn impact maintenance.

8.1.1 Goals

The purpose of the Management and Maintenance Plan is to identify the management, staffing, equipment, and procedures that are needed to ensure that the dredging, daylighting, re-vegetation, establishment of Best Management Practices (BMPs), and other construction that will take place in Phase I will be sustained. The goals of the Management and Maintenance Plan are:

- To ensure the success of the five objectives of the Muddy River Restoration Project which are:
    1. Provide flood control;

2. Improvement of water quality;
3. Enhancement of the aquatic and riparian habitat;
4. Historic rehabilitation; and
5. Implementation of Best Management Practices for stormwater runoff.

- To incorporate and adapt management and maintenance procedures for improved parkland.
- To identify specific problems/issues relating to maintenance operations and to develop strategies for dealing with them.
- To prepare a prioritized list of projects to be undertaken in the parks and which must be included in the MEPA Annual Update. Projects may be certain unusual maintenance items or elements of the Master Plan that the group may want to incorporate in a given year.
- To explore available resources (personnel, financial, equipment community, institutional) including those not already utilized and to make the best possible use of them.
- To assure that key parties are involved in preparing the maintenance operations plan and to develop an ongoing forum for communication.
- To develop a realistic schedule and standards for maintenance activities, addressing the needs and concerns of all parties.

8.2 Management and Resource Structure

Upon completion of the Phase I Muddy River Project, nearly 100 million dollars will have been spent from federal, state, local, and private sources. In order to ensure that this level of investment is protected and preserved, a management and maintenance structure for the parks must be in place.

Management and maintenance of the rehabilitated Muddy River project area and ultimately the Emerald Necklace will depend on implementation of a structure that assures consistent oversight of the park areas and an advocacy to support and provide the resources to maintain the park areas over a long term. Upon investigation of other successful park management structures, it is also clear that the future structure may be different than the initial structure that needs to be put in place. Successful park management organizations evolve over a long period of time as they develop relationships with community groups, conservancies and governmental organizations. The key element seems to be leadership with the willingness to change structures over time and to incorporate beneficial interests into the park management. Many, but not all, of the organizations studied are based on the sources of funding to maintain the park and management structure.

As project proponents, the City of Boston and Town of Brookline have developed a plan for rehabilitation of the Muddy River with the long term view that it will be the beginning of meeting the goals of the Emerald Necklace Master Plan (see Section 9, Table 9-5). Developing the funding and the management structure will necessarily take time for the governmental entities involved to negotiate and agree upon. In order to meet the intent of the Secretary's Certificate, several alternative management structures are presented that could form the basis for discussions and decisions prior to submitting the Final EIR. In any case, we should realize that the initial governance structure is likely to change over time as other entities begin to participate in the overall success of the Muddy River rehabilitation.

The following management structures will be described as alternatives for the project proponents to formulate the initial organization for future Emerald Necklace management:

- Existing Management Structure (status quo);
- Cooperative Management Structure;
- Public/Private Partnership;
- Entity Under the Environmental Joint Powers Act; and
- Park Commission or Authority.

Formulation of the alternative management structures was based on identifying several options available under Massachusetts' regulations and also canvassing several other successful park management organizations across the country. Clarissa Rowe of Brown and Rowe, Inc. contacted several parks in the country and prepared a comparative summary table of the organizations. Table 8-1 presents the results of this work. All 4 parks that responded to the inquiry, Central Park and Prospect Park in New York City, Louisville's Olmsted Parks and Pittsburgh Parks, have a form of public / private partnership with an active conservancy. In addition, the head of the conservancy is on the staff of both the municipality and the conservancy and leads the park oversight of both public and private staff. These organizations are quite mature with one over 20 years old and the partnerships have changed over time as the conservancies gain support and funding. None of the example organizations identified included the multiple jurisdictions facing the Muddy River, so that direct analogies are difficult.

While preliminary discussions have already taken place on the issue of management, after the DEIR is issued, the proponents will be engaging in discussions to determine which structure will fit their short and long term goals. A recommended initial management structure will be identified in the FEIR. Some of the benefits and drawbacks of the various alternatives are included in the discussion of alternatives below.

Muddy River Reconstruction Project

DRAFT– 12/10/01

Emerald Necklace Parks - Comparison to other park models

	Central Park	Prospect Park	Louisville's Olmsted Parks	Pittsburgh Parks
A. Parks				
1. Acres	843 Acres	526 Acres	15 miles of parkway, 1200 acres of parkland	200 Acres
2. Number of Owners	1	1	2 – Metro Parks and Jefferson County	2 – Pittsburgh Parks Department and Pittsburgh DPW
3. Designed by Olmsted	YES, and Vauz	YES	YES – 18 parks of the 119 total parks and all 6 parkways	NO
4. Annual Operating Budget	20 million, 80% is raised privately	*	No dedicated funding stream for Olmsted Parks	*
5. Annual Capital Improvements budget	Varies from 3-10 million per year, an average of $5 million per year.	1.2 percent of operating budget	$11 million	2.2percent of operating budget for total system
6A. Park Staff # 6B. Conservancy Staff #	45 160 in the field, 25 seasonal, 45 in programming and development	* 42	Metro Parks: 350-375 permanent and up to 2000 seasonal Conservancy: 10 with 2 positions currently unstaffed (5 FT, 5 PT) Park staff works as adjacent staff	* 5
7. Is there a Master Plan? Date?	1985, Restoration Master Plan	Olmsted original plan	1994, Andropogon Associates, detailing 50 million $ in capital improvements	Yes, team of 5 firms, late 2000
8. Conservancy Founded	1980	1987	1989	1996
B. Park Management				
1. Meeting of Commissioners/Owners per year	The Commissioner meets with the Conservancy Board four times a year.	*	Monthly	Monthly
2. Relationship of Owner to Owner if multi-jurisdictional	They work together. Doug Blonsky works as Central Park Administrator/Chief Officer for both entities.	NA	Bridgid Sullivan is the Parks Director for both city and county parks but depending on location, City Aldermen or County Commissioners should be involved.	Park ombudsman
3. Relationship of field staff to field staff (do you have joint work days?)	They work together	NA	Maintenance supervisors meet quarterly	Conservancy staff talk to each parks foreman
4. Park tasks outsourced	Maintenance management to the Conservancy. They also hire out some tree work and their capital improvements work. The City's transportation dept cares for lighting, enforcement handled by policy, city plumbers do fountain work.	Tree pruning care; Invasive plant removal	Public Works for lighting, Metropolitan Sewer District and Louisville Water Company for plumbing, and tree pruning is contracted out	*
5. Does each park have own supervisor?	Yes, there are seven sections and each section has a head, then there are zones that are headed up by	Yes	Yes	At least a foreman

	Central Park	**Prospect Park**	**Louisville's Olmsted Parks**	**Pittsburgh Parks**
	zone gardener.			
6. Is park equipment bought by outside sources?	Yes, the Conservancy gets donations and then deeds them immediately to the City who will pay for the gas and the insurance for the equipment. (The Conservancy has the equipment mechanic on their payroll.	Yes	No, Parks department budget pays for equipment	*
7. Are there performance criteria for park work?	They have zone based inspections. Each zone prepares a work plan that deals with cleaning and horticulture. Doug Blonsky said it was crucial to give this power to the zone heads.	*	Mesude Duyar, the new Director of Forestry has recently raised the standards for maintenance, specifically forestry and horticulture. So far she has produced a Performance Manual for one Park (Iroquois Park) with more to come. This is also an annual horticultural maintenance audit conducted by an outside committee.	*
8. What is the maintenance budget per acre of parkland?	It varies. About $12,000 to $13,000 an acre.	80-100 hours per acre	$24 million 14,500 acres	*
C. Park Conservancy / Alliance	**Central Park Conservancy**	**Prospect Park Alliance**	**Louisville's Olmsted Parks Conservancy**	**Schenley Park Conservancy became Pittsburgh Parks Conservancy**
1. How much money did it raise in the first five years? In the first ten years? Total?	Conservancy has raised a total of $300 million to date. In the first 7-8 years, they raised $50-60 million, with another $60 million in the following 7 years.	*	$1 Million seed money from city, $8 Million in donations to leverage $4.5 Million from city.	First year: $300,000 in cash donations, $400,000 in-kind services.
2. What were its first tasks?	Accomplished projects: Restoration of the Dairy, Bethesda Fountain, Belvedere Castle and Annual Lunch.**, The Design Office also had design projects designed and ready to put into the city budget at a moment's notice.	Tours of resource. Put a name and positive image in public realm. Put together a strong board of directors w/ credibility in funding field.	Raises private funding for joint capital improvement projects; Participants in planning and design; Administers Park Champions Volunteers	Fundraising; Create membership; Coordinate other civic organizations advocacy.
3. What are its standing committees?	Executive, finance, nominating, community relations, investment, development, marketing and communications, audit. Committees meet 4x year, audit 1x, investment 2x.	Operations, community, fundraising.	Board of Trustees Executive Committee Finance Com. Development Com. (Funding) Nominating Com. Construction Com. Community Relations *Temporary: Reorganizational Com. – currently meeting twice a month	*

	Central Park	Prospect Park	Louisville's Olmsted Parks	Pittsburgh Parks
is it involved?	insurance company		members being up for re-election each year, self perpetuating	
5. Is the head of the Conservancy a technical or political person or both?	Elizabeth Barlow Rogers, first head of Conservancy, was also Central Park Administrator. The President of the Conservancy is primarily a fundraiser. D. Blonsky is a technical person with a degree in Landscape Architecture and Horticulture.	Both; initially political, Tupper Thomas has both head titles.	Susan Rademacker, assistant parks director for planning and design and President of Conservancy; now her deputy is public employee Currently paid half by the city and half by the Conservancy; by 2003 will be paid entirely by Conservancy	Political; separate from Parks or DPW; Meg Cheever is a former editor and cultural institution administrator.
6. How does the Alliance staff work with the public park staff?	Side by side	Interchangeable. Alliance funds positions for public sector.	They work side by side on Olmsted/Olmsted Brothers designed parks	Separate funds.
7. How is the $ raised accounted for?	Annual lunch, corporate contributions.	Yearly audits reviewed by Alliance Board and NY Parks Dept.	Yearly audit reviewed by the Conservancy Board and the Louisville Parks Department	*
8. How is the credit given to donors in a public park?	Various ways, including small plaques on boulders, annual report, annual recognition ceremony. Now thinking of recognition in paving in one location for smaller donors.	Shields on new trucks/ equipment, written material. Donations immediately deeded to City of New York.	Plaques on benches and trees Wall plaques in the renovation of the Iroquois Amphitheater Naming of pavilion in Cherokee Park and of the Iroquois Amphitheater Annual reports	*
D. Involvement of Park Advocates		New Community Committee as of 1996 (Prospect Park)	Louisville Friends of Olmsted Parks 1986	
1. Is there a volunteer coordinator?	Yes, and a web page - volunteer@centralparknyc.org. Volunteers have a direct relationship with the zone gardeners. Zone gardeners are trained to deal with volunteers and get a point in their salary review for this work.	Yes, took 2 years of meetings.	Yes, and a web page - www.olmstedparks.org/volunteer.htm Park Champions play a major role in Invasive Species removal and other landscape projects Park Stewards provide park information and maps to users Office support: help with mailings Communication: assist with writing and editing publications and trail guides Archives: set up and maintain systems for storing publications, drawings, clippings and photographs	Yes, one in DPW, one in Conservancy.
2. Where is the person housed?	In Conservancy offices	In Park	In Conservancy offices	Both places
3. What contributions do the advocates make towards the park besides financial	Planting, pruning when trained, mowing, mulching. (Rich volunteer bring their own	Look at yearly work plan, help staff with operational directions	Community committees to look at park needs, do clerical and informational work.	Advocate Volunteers Marketers

	Central Park	Prospect Park	Louisville's Olmsted Parks	Pittsburgh Parks
contributions?	equipment to do chores.)			Park stewards
4. How do the advocates interact with the public park staff? How are they involved with the Alliance or Conservancy?	See above. Zone gardeners are trained to stop and talk to volunteers. Volunteers have regular small gatherings to talk. Outreach coordinators work with them to assess and investigate problem areas.	Work with park and alliance staff on operational decisions. Work on 5 and 20 year comprehensive park plan. Staff works to frame decisions.	Park staff directs conservancy volunteers. Friends are aggressive advocates.	Through monthly meetings and park ombudsman. Conservancy attends monthly meeting.
5. Do the advocates have a forum to discuss future park plans?	Small gathering promoted by outreach coordinators.	Yes, but not a legal one.	Input in Master Planning Process, serve as advisors, stewardship councils.	Once a month
6. What maintenance items do the park advocates undertake?	See 3. Above	Planting, erosions control, water sampling, vegetation monitoring and control.	Remedial maintenance, trails, invasive species removal through Park Champions.	The ones suggested by the park foreman.
7. Other Helpful Quotes	"In 1998 the city of New York awarded the Central Park Conservancy a management contract that ensures the continuing maintenance, public programming, and capital restoration of Central Park." ***	"Everything takes a long time." "Keep evolving and do no harm."	"Basically the Friends of Olmsted Parks work from the outside advocating for the parks, while the conservancy works from the inside."	*

Notes:

* = Information not available or no response received.

**"I had to make the people of New York City see the park in the same light as the Museum of Natural History or the Bronx Zoo or the Botanical Gardens" said Betsy Barlow.

***Dough Blonsky of Central Park says that they putting together a pro bono business team to do audits of other parks. They will visit the parks and make recommendations after seeing the parks and will help facilitate meetings if asked.

This material collected from two sources: Inside City Parks by Peter Harnik, published by the Urban Land Institute and the Trust for Public Land, Washington, DC 2000; and Public Parks, Private Partners: How Partnerships are Revitalizing Urban Parks, Andrew Schwartz, Editor, published by Project for Public Spaces, New York City, NY, 2001; and from conversations with Tupper Thomas, Susan Rademacher, Tim Marshall, Pam Tice, Gerry Weinstein, Hannah Ehrlich, Simone Auster, Chris Noonan, Sarah Peskin, Richard Spaulding, Jackie Selby, Justine Liff, Erin Chute, Tom Brady, Samantha Overton Bussell, Joe Geller, Arlene Mattison, Hugh Mattison, Richard Heath, Charles Birnbaum, Arleyn Levee, Betsy Shure Gross, and Roy Blomquist.

Compiled by: Brown & Rowe, Inc. with additional information about Louisville compiled by Angela Parker (Boston Parks & Recreation Dept.)

8.2.1 Existing Management Structure

Under the existing management structure, the City of Boston, Town of Brookline and the Metropolitan District Commission (MDC) each maintain a portion of the project area and are individually responsible for staffing and funding this work. There is no structure in place responsible for coordinating or assuring that ongoing maintenance is done to a specific set of standards or practices.

The City of Boston through the Boston Park and Recreation Department (BPRD) is responsible for maintaining 117 acres of park of which 27 acres are water. The maintenance is organized into 6 regions with Region 5 responsible for the Muddy River section of the Emerald Necklace area. The Parkman Crew, a specialized horticultural crew, also works in the project area, most of the Emerald Necklace parks and other historic parks. . The Parkman program also funds some contract work in the Muddy River area and other specialty trades, and tree crews covering the entire city contribute to maintenance in the Muddy River area. BPRD maintenance includes daily park maintenance (primarily cleaning and mowing), trades, horticulture and tree maintenance.

BPRD is also responsible for 8 pedestrian and 1 vehicular bridge in the park. Boston Public Works Department (BPWD) is responsible for 6 bridges in the park area.

The Town of Brookline through the Parks and Open Space Division is responsible for maintaining 32 acres of park of which 8 acres are water. The Parks and Open Space Division is a part of the Department of Public Works. The maintenance is organized into three geographical zones, two of which are responsible for the Muddy River area.

Brookline maintenance activities are similar to the BPRD activities.

The MDC is responsible for the Charlesgate area, the former Kelly Rink site, the parkways, catch basins and a 25 foot strip of park from the curbline totaling about 35 acres of which 4 are water. The Charles District crews maintain the Muddy River area as part of their overall responsibility for the Esplanade, Charles River Basin and the McGrath / O'Brien Highway. MDC maintenance is limited to mowing, delittering and fall leaf removal. Catch basin cleaning is sporadic.

The Massachusetts Highway Department (MHD) and Massachusetts Turnpike Authority (MTA) are responsible for maintaining the bridges over the Muddy River owned by the respective agencies.

Under the current management organization there is little coordinated maintenance in the Muddy River area with only informal cooperation among the park crews and supervisors. The resulting maintenance is clearly non-uniform throughout the park area. Funding for the staff and materials is through the individual governing bodies and subject to competing annual budget constraints. As discussed in a succeeding section , current staffing levels will not be adequate to maintain the proposed Muddy River restoration area.

8.2.2 Cooperative Management Structure

The cooperative management structure for managing the Muddy River area is comprised of the City of Boston, the Town of Brookline, and the Metropolitan District Commission (MDC), each continuing to maintain its respective portion of the park in concert with a unified plan. The Executive Office of Environmental Affairs (EOEA) and the Department of Environmental Protection (DEP) are responsible for ensuring that the requirements of the Certificate from the Secretary of Environmental Affairs and that compliance with regulatory programs is maintained. The management structure is illustrated in Figure 8-2.

The concept of the management structure would be for a senior representative of each entity with parkland responsibilities to meet and set policy and goals for work inside the project area, parkland (park maintenance) and for work outside the parkland (principally BMPs). These representatives would be Commissioner/Director level at each agency and have the ability to commit resources or influence the commitment of resources to the management and maintenance effort.

Working with the management group would be the horticulturist, arborist, maintenance supervisor or operations managers to advise on setting policy and goals. Collectively this group represents the maintenance managers for each entity and they would also meet separately to work on implementing the goals and policies set out by the management group.

Issues outside the parkland areas are principally BMPs that will be owned or conducted by several parties such as Boston Public Works Department, BWSC, MDC, the Town of Brookline and the Brookline Department of Public Works. The goal for outside parkland work is that signatories to the MOU will meet their maintenance and implementation commitments and work to coordinate their activities through the management group. As new BMPs come online, the management group and each entity will reach a consensus to establish maintenance procedures and the entity will report results so the management group can complete the Annual Update Report for MEPA.

A regular schedule of coordination meetings between the Boston/Brookline/MDC Commissioner/Director, Maintenance Supervisor/Operations Manager, and Foremen will take place to coordinate efforts and to share lessons learned. The Annual Review Calendar is shown in Table 8-2.

The MDC, in particular, has suffered extensive budgets cuts affecting their ability to meet their existing maintenance responsibilities, let alone additional responsibilities. The ability of the MDC to meet the additional maintenance responsibilities resulting from the completed Muddy River Restoration Project is questionable without a substantial increase in their operating budget. The City of Boston and Town of

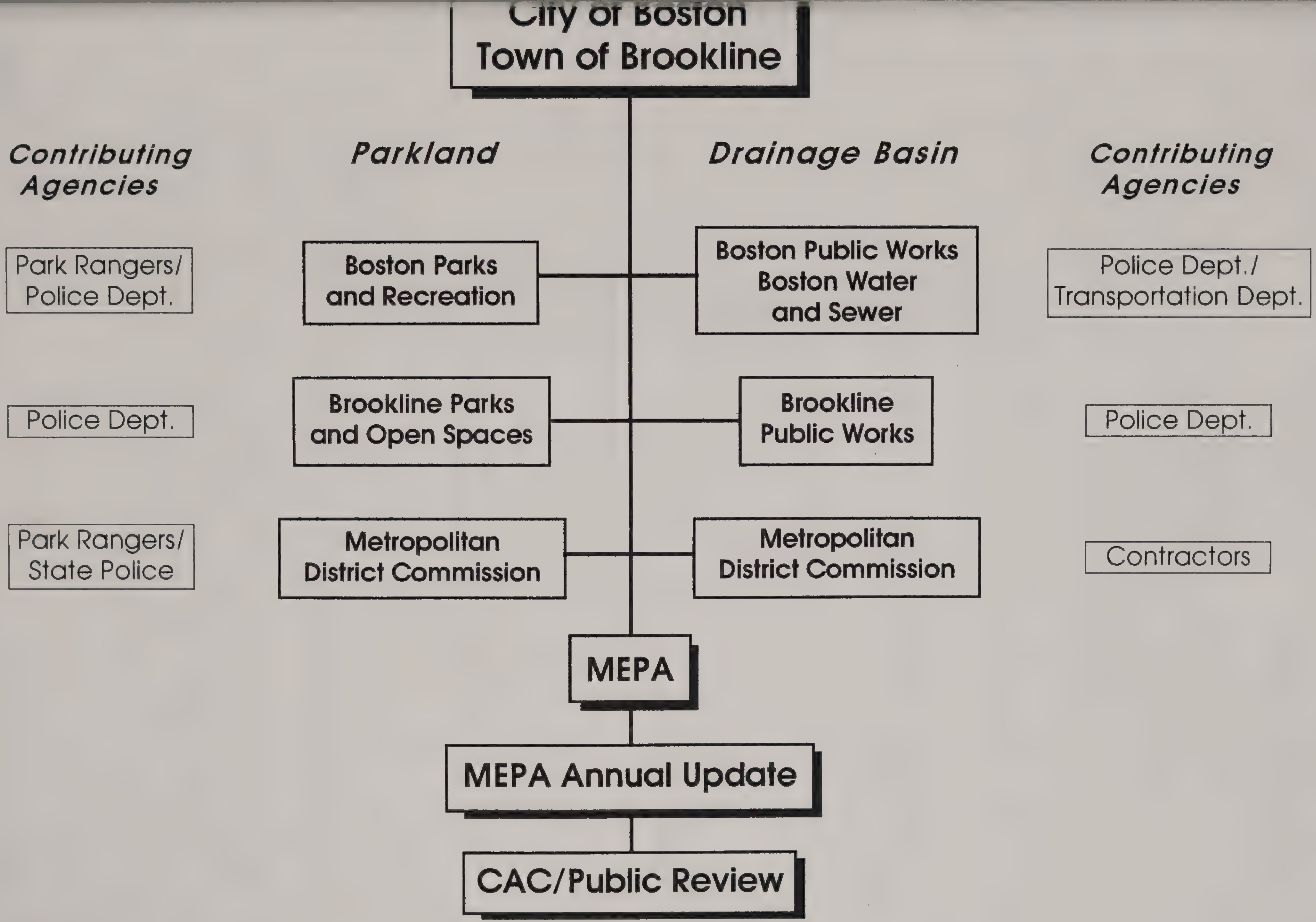

City of Boston
Town of Brookline
Contributing Agencies
Parkland
Drainage Basin
Contributing Agencies
Park Rangers/ Police Dept.
Boston Parks and Recreation
Boston Public Works Boston Water and Sewer
Police Dept./ Transportation Dept.
Police Dept.
Brookline Parks and Open Spaces
Brookline Public Works
Police Dept.
Park Rangers/ State Police
Metropolitan District Commission
Metropolitan District Commission
Contractors
MEPA
MEPA Annual Update
CAC/Public Review

Figure 8-2
Park and Drainage Area Management Structure

Table 8-2
Annual Review Calendar
Schedule of Strategy Meetings and Review Sessions

Month	***Meetings/Review Sessions***
January	■ Boston, Brookline and MDC management meets to: 1. Review the progress of work to-date; 2. To establish the goals and programs for the following year; 3. Prepare a list of priority projects; and 4. Review/submit the MEPA Annual Update. ■ Boston, Brookline and MDC horticulturist, arborist, Maintenance Supervisor, Operations Manager and foremen meet to (held before management meeting to provide input): 1. Present accomplishments from previous year; 2. Establish objectives for the present year; 3. Identify means of completing these projects; 4. Seasonal scheduling; and 5. Update the Maintenance Operations Plan to include new plantings, structures, etc. from the previous year and from comments and observations.
February	■ Publish an updated Maintenance Operations Plan. Potential CAC meeting to review and update set up by MEPA.
March	■ Present the updated Plan to the maintenance units
April	■ Operations
May	■ Operations
June	■ Operations
July	■ Operations ■ Boston, Brookline and MDC horticulturist, arborist, Maintenance Supervisors meet and make a mid-season review of priorities, goals, projects and operations.
August	■ Operations
September	■ Operations
October	■ Operations
November	Boston, Brookline and MDC horticulturist, arborist, Supervisors and foremen meet and review priorities, goals, projects, and operations. Prepare MEPA Annual Update.
December	Review and analyze Maintenance Operations Plan. Generate priority project lists for January meeting and distribute to Planning and Maintenance staffs. Generate preliminary list of goals and objectives for the following year and distribute to management staffs. Submit MEPA Annual Update to management and upon approval submit to MEPA.

Brookline should support the MDC in its efforts to increase its operating budget. If there is no substantial budget increase, the three municipalities will need to discuss options for maintenance of those areas within the MDC's jurisdiction. The MDC is responsible for approximately 35 acres or 19% of the project area that is highly visible and would dramatically affect overall park maintenance levels. Failure to maintain those areas up to standards will only serve to increase the public perception that little or no maintenance is being done. If the MDC continues to suffer budget cuts in its operating budget, other strategies for maintenance of its areas will need to be discussed and investigated, including, perhaps, the basic issue of management control.

An important element in any governance structure will be tapping into the intense community interest for this park area. A community and volunteer liaison should be identified to coordinate communications with various community groups and also to coordinate the use of volunteers. Community groups serve two important roles. They keep the park management abreast of public issues that need to be addressed and can also mobilize community volunteers for specific projects. The volunteer program needs to be coordinated with the park supervisors so that volunteer work enhances the work of the staff and that the park management can provide support in the form of equipment or supervisory staff to oversee the volunteer work. One area suggested for volunteer work is in woodland maintenance.

8.2.3 Public/Private Partnership

Public / private partnerships (Partnerships) can take many forms depending on the relationship and involvement of the parties. Of the examples from other park systems surveyed, the organization generally took the form of a conservancy leading the organization with the public entity providing portions of the staffing (including the director) and some funding. In each case the system was located within one municipality, although management responsibilities were sometimes shared with a number of city departments. These organizations developed out of unsuccessful public programs that needed structural changes in the way parks were managed.

The Emerald Necklace Conservancy (ENC) is a relatively new and growing organization that to date has concentrated on establishing relationships with various constituencies around the Necklace with the aim to enlist private support for maintenance of various park segments once the rehabilitation is in place and to rehabilitate other park areas beyond the river itself. If the organization grows in stature and resources over time, then maybe a modified Partnership can be implemented more along the lines of the other park systems surveyed.

At this time it is unrealistic to assume that the ENC could generate significant funding from private sources until the rehabilitation is more visible. As the initial project improvements are completed ENC may be able to generate more revenue from the private sector and take on a larger role.

8.2.4 Entity Under Environmental Joint Powers Act

Section 20 of Chapter 21A of the General Laws of Massachusetts allows two or more public agencies to enter into an agreement to jointly exercise jurisdiction and responsibilities over specific areas or regions. The intent of the "joint powers agreement" is to facilitate intergovernmental action on natural resource and environmental issues. Two or more public agencies, for any region they may decide, may jointly apply to the Secretary of Environmental Affairs to enter into an agreement to jointly oversee duties and responsibilities. The agreement specifies: 1) the purpose and nature of the agreement; 2) the duties and responsibilities to be shared and how they will be divided; 3) the estimated costs and methods of financing; 4) the method of administration; and 5) the duration of the proposed agreement.

The law requires a public hearing, and upon a written finding that the agreement meets the law's requirements, the Secretary may approve the agreement. The Secretary then files an approved copy of the agreement with the Senate, House of Representatives, and State Secretary. If the agreement is not disapproved within 45 days after the public hearing, the agreement is considered approved. Agreements can be modified and durations extended by the Secretary, but agreements cannot last more than 5 years without express statutory approval. The agreement can be administered by a board comprised of at least one member of each public agency participating in the agreement.

An example of the Environmental Joint Powers Agreement is the Upper Mystic River Watershed Agency. Nine communities have agreed to form an agency to address flooding problems in the Mystic River Watershed. The purpose of the organization is to address hazard reduction of floods jointly since independent actions for hazard reduction can impact other communities in the watershed. The agency is allowed to expend money received from state and federal agencies as well as private sources to defray operational, administrative and contractual costs.

One weakness of the Upper Mystic River Watershed Agency agreement is that the member communities are not obligated to provide funding to the Agency until the appropriating agency within the community authorizes funding or payment. Where the work of the Agency is mostly coordinating actions and expending study funds from state and federal agencies this is not been a problem. Work can also be scheduled when funding is available. If the Agency extends its function to conduct more ambitious projects the local appropriation could become more problematic.

8.2.5 Park Commission or Authority

Under Massachusetts General Law certain Commissions or Authorities can be formed for the purpose of administering an organization dedicated to a specific public purpose. Special legislation can also be filed to form these Commissions or Authorities that are not specifically outlined in the MGL. The actual organizational structure of these commissions or authorities can vary significantly and are a function of the negotiations of the parties agreeing to form the organization. Legal assistance needs to be sought to prepare the legislation or formation documents outlining the specific organizational structure. In simple terms, a commission or authority is a central organization with a structure separate from the towns and cities involved. There can be representation of the current organizations or completely separate structure in the commissions and authorities.

A source of funding is the key element in any of the commission or authority organizations. Since the parks are generally non-revenue generating entities, an appropriation from the owning agencies or outside funding must be obtained. These funding and structural arrangements can only be formed if there is sufficient political support in the member communities and surrounding areas to cede control of park areas and secure sufficient funding streams to make the arrangement successful. A sponsoring group will have to assume the role of facilitator to make this type of organization come together.

8.2.6 Other Resources to Management Structures

Irrespective of which management structure is ultimately selected, there are several sources of resources that the entity should take into account. Community advocacy is a strong force in the Emerald Necklace project area and should be an active partner in the effort to maintain the parks. Several forms of participation will be considered during the formation of the management organization.

One model is a community council where representatives of various community groups form a standing committee or council and are incorporated into a regular advisory role for the project proponents. In this role, discussions on upcoming projects, previous years results or new issues can be incorporated into the proponent's plans for the upcoming year.

A second model that is already functioning is the Emerald Necklace Citizens Advisory Committee. This CAC has a defined role under the MEPA regulations as advisors to the Secretary of Environmental Affairs. In ongoing and future work contained in the Certificate the CAC would have a continuing role.

Another resource are the volunteers. Volunteers can provide additional staffing to accomplish certain projects outlined in the yearly for the parks and also through volunteers with special skills can accomplish special projects. Volunteers can be matched with supervisory staff or work directly for the management of the organization. In any of the management structures, there will be a recognition of volunteers and a plan developed to tap the benefits of volunteer providers.

8.3 Accountability

As part of the commitment to the Muddy River Rehabilitation project, the City of Boston and the Town of Brookline have been asked to show how they will be accountable to the maintenance and management of the project over the long term.

- The proponents have already signed a Memorandum of Understanding (copy in Appendix L) committing to funding the maintenance of the project in return for assistance from the state on capital expenditures for the project.
- A quality assurance program through reports and logs will be part of the maintenance program to document maintenance activities.
- An Annual Update of progress will be provided to MEPA where a built-in public comment process assures public involvement.
- Certain activities to be accomplished each year will require permitting where state agencies can provide guidance on future activities.
- The following paragraphs discuss each of the areas assuring continued commitment by the proponents.

8.3.1 Environmental Reporting Framework – The MEPA Annual Update

Annual Updates to MEPA are required under the Special Review Procedures for all phases of this rehabilitation project. They must be filed annually as a means of informing the Secretary and the public of progress on project implementation, monitoring and effectiveness of mitigation and replanting.

Though not strictly a regulatory or statutory requirement, a proposed outline for the Annual Update (AU) was required by the Secretary under the Special Review Procedures (see Section 9.3.6.7). Its purpose generally is to provide continuity and flexibility in the reporting on progress of the Muddy River Project. Based on the proposed schedule for advancing the Charlesgate portion of the Muddy River Project, it is assumed that the first AU filed, will provide an update on the progress of implementation of Charlesgate improvements and on the mitigation effectiveness at that location. The first and subsequent updates would also report progress on the remaining portions of the project to be implemented after Charlesgate. In this manner, the local, state, and federal agencies and the public will be appraised of and have the opportunity to comment on the following:

- The ongoing Management and Maintenance Plan;
- The results of monitoring programs and the implementation of BMPs;
- The progress of the dredging and restoration/rehabilitation work;
- The successes and shortcomings of the work;
- Modifications to procedures to enhance the success of the work; and
- Future plans for additional work that was not covered in the EIR.

It is expected that the Secretary of Environmental Affairs will also request comments on the Annual Update report from stakeholders. In this way the Citizens Advisory Committee and other public interest groups can continue to contribute to the project and future activities.

8.3.2 Maintenance Environmental Permits and Approvals

The environmental permits and approvals to be obtained for the Phase I Project (see Section 9) include:

- Certificates on the draft and final EIRs from the Secretary of Environmental Affairs;
- Department of the Army Permit under Section 404 of the Clean Water Act for the dredging;
- Permit to Dredge under M.G.L. ch. 91 from the Department of Environmental Protection;
- Finding of no adverse effect from the Massachusetts Historical Commission, the Brookline Preservation Commission and the Boston Landmarks Commission in their role as a certified local governments;
- Approval from the Boston Landmarks Commission for work on a Boston Landmark; and
- Orders of Conditions from the Boston and Brookline Conservation Commissions.

It is expected that the conditions and requirements of these permits will also include requirements during maintenance. Examples include such things as invasive control where work will occur in areas governed by the WPA. Replanting would also come under Conservation Commission jurisdiction.

Under the Wetlands Protection Act, the Orders of Conditions are specific as to the type and extent of work that is permitted, not only under Phase I but for succeeding Phases. Several Orders of Conditions are expected to be obtained on the project. The first for Charlesgate and the second for remaining Phase I work. The Order of Conditions for the Phase I work will be issued and can be extended for up to five (5) year duration. However, due to the potentially variable nature of rehabilitation and other work that may take place in resource areas in subsequent years, the Orders of Conditions are expected to contain the requirement that the Proponents appear before the Conservation Commissions each year immediately following the filing of the MEPA Annual Update. Once the Secretary of Environmental Affairs issues the Certificate on the Annual Update, the Conservation Commissions may then issue amendments to the original Orders, as necessary.

This is the mechanism by which the Conservation Commissions will be able to review and approve any continuing rehabilitation within the resource areas.

8.3.3 Reports and Logs – Quality Assurance

As part of meeting the intent of the Certificate from EOEA, a series of logs or monitoring reports will be prepared to document that the project is meeting the intent of improvement of the park areas. All of these items should be included as attachments or summarized in the Annual Update Report to MEPA.

Several monitoring activities, inspection and maintenance documents have been identified in Section 8. A listing of those deliverable items with their frequency of reporting and responsibility is included in Table 8-3.

As part of running a maintenance program, the parks' managers should create a maintenance plan document describing how to carry out the specific maintenance activities discussed in this report. BPRD already has a plan that can be modified. Over time the maintenance plan gets outdated as practices change or as staff develop better ways of accomplishing the work to be done. This plan should be updated periodically to address the changes in practice.

Table 8-3

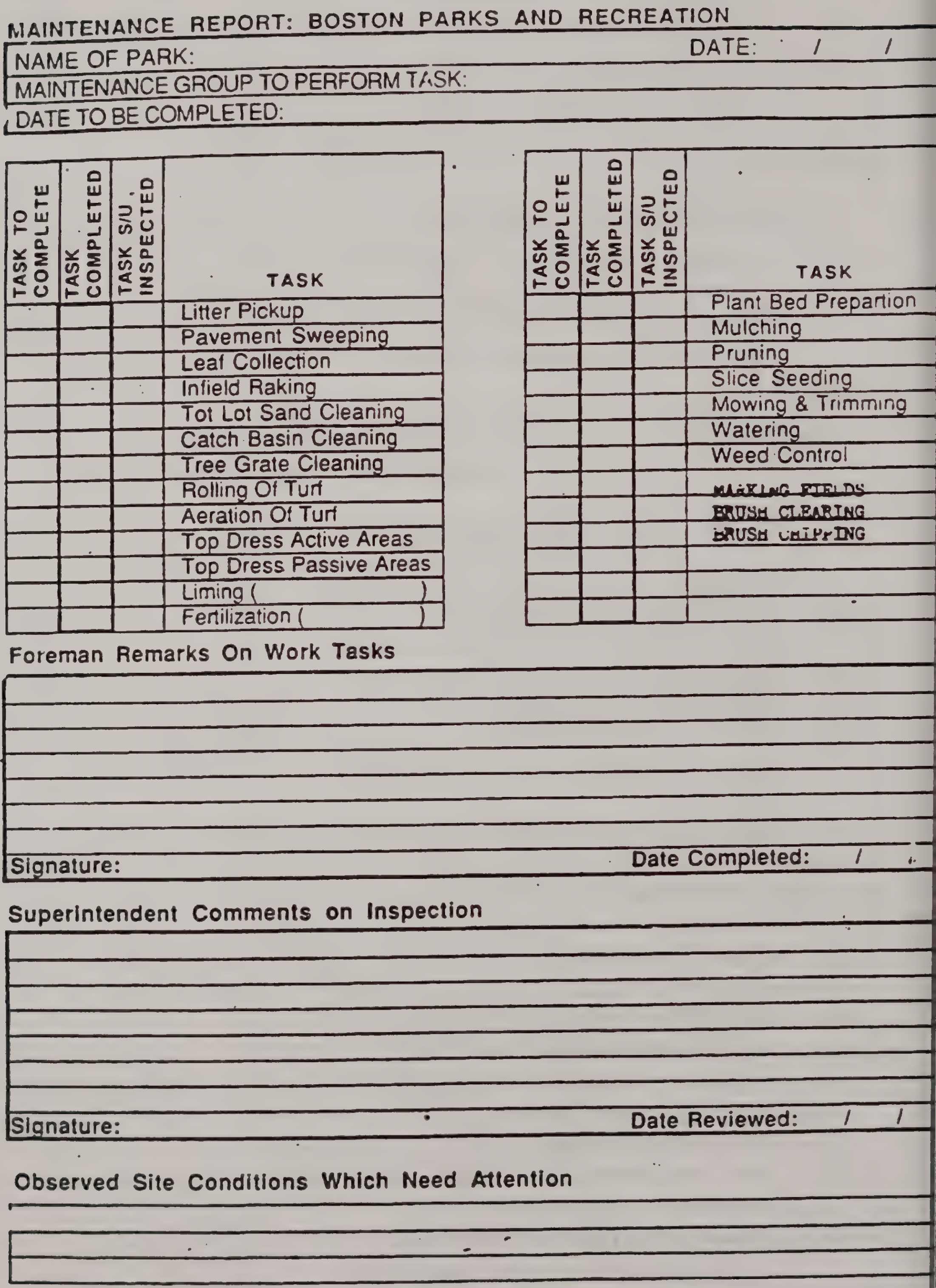
Summary of Monitoring/Inspections

Description (Section)	***Frequency of Reporting***	***Responsible***
Update Maintenance Operations Plan (8.3.3)	Annually	Management Group
Maintenance Logs (8.3.3)	Annually	Maintenance Supervisors
BMP Monitoring / Maintenance Logs (8.6.4)	Annually	Maintenance Supervisors
Pest Control Programs (8.8)	Annually	Management Group
Water Quality Monitoring Program* (8.9.1)	Annually	Management Group
Report on Plantings (8.9.2)	Years 1,3,5 Every 3 yrs after	Horticulturist
Report of Aquatic and Wildlife Distribution (8.9.3)	Bi-Annually	Management Group/Biologist
Report on Historic/Character Defining Features (8.9.4)	Annually	Management Group/ Landscape Architect

* Samples taken quarterly and reported annually

As part of the maintenance plan, maintenance logs should be created to document that maintenance was completed and if there are any follow up activities that need to take place. A sample of a maintenance log is included as Table 8-4. This is a sample of BPRD maintenance log already being used, and similar logs should be developed for each park maintenance activity by each entity performing maintenance. This log can be developed into simplified electronic database to facilitate use and application for the Annual Report to MEPA. Maintenance logs are the basis of quality control for park maintenance but an overall management review and evaluation of the quality control must be conducted to assure compliance (quality assurance). An example would be the Division Quality Control Program conducted for BPRD.

Table 8-4
Sample Maintenance Log



MAINTENANCE REPORT: BOSTON PARKS AND RECREATION

NAME OF PARK: DATE: / /

MAINTENANCE GROUP TO PERFORM TASK:

DATE TO BE COMPLETED:

TASK TO COMPLETE	TASK COMPLETED	TASK S/U, INSPECTED	TASK
			Litter Pickup
			Pavement Sweeping
			Leaf Collection
			Infield Raking
			Tot Lot Sand Cleaning
			Catch Basin Cleaning
			Tree Grate Cleaning
			Rolling Of Turf
			Aeration Of Turf
			Top Dress Active Areas
			Top Dress Passive Areas
			Liming ( )
			Fertilization ( )

TASK TO COMPLETE	TASK COMPLETED	TASK S/U INSPECTED	TASK
			Plant Bed Prepartion
			Mulching
			Pruning
			Slice Seeding
			Mowing & Trimming
			Watering
			Weed Control
			MARKING FIELDS
			BRUSH CLEARING
			BRUSH CHIPPING

Foreman Remarks On Work Tasks

Signature: Date Completed: /

Superintendent Comments on Inspection

Signature: Date Reviewed: / /

Observed Site Conditions Which Need Attention

The Annual Update Report to MEPA is the responsibility of the management group for preparation, review and submittal. This report could be prepared by in-house staff and share costs or contracted to an outside consultant. The cost and sharing of costs for preparing this report is estimated in Section 8.

8.4 Park Maintenance Activities and Workload

Maintenance for the project area consists of maintaining the park assets such as lawns, trees, shrubs, walkways, benches and amenities and also maintaining the ancillary aspects of the project such as culverts, water quality, BMPs and habitats. This section will discuss the issues with maintaining the park assets.

As part of the evaluation of the park maintenance issues ETM Associates, L.L.C. (ETM) was requested to make an evaluation of the maintenance in the project area and recommend a program of improvements consistent with their experience in other large urban parks. The ETM report is included in Appendix J in its entirety and sections are summarized here as part of the overall Management and Maintenance Plan. In the ETM report the project area is referred to as the "Muddy River Parks of the Emerald Necklace" although Muddy River Parks is not an official designation of the project area along the Muddy River.

8.4.1 Maintenance Standards

In evaluating the needs for higher maintenance standards the different types of landscapes must be considered. In the project area, the maintenance needs differ in each area, namely woodlands, parkland, planting areas (shrubs and perennials), embankment plantings, water and site furnishings. It is critical that the management organization help develop the maintenance standards and all governing parties contribute to a uniform set of standards.

The priority in these park areas is to raise the maintenance standards in the following particular areas:

- Horticultural Care

  Additional resources are needed to meet the horticultural needs of the park. Shrub plantings are in need of watering, weeding, pruning and fertilizing.

- Turf Maintenance

  Higher standards of turf care including a recommended seven-day mowing schedule, reseeding, fertilizing, aeration, and soil testing are needed to ensure a high quality turf.

- Tree Care

  The existing trees need of pruning, thinning and in some cases removal of dead or dying trees.

- Woodland Management

  Additional specialized crews or contracts are needed for woodland management.

- Water Body Management

  Specialized skills are needed to monitor and maintain water quality throughout the project area.

- Erosion Control

  As a mature landscape with considerable use, the project area suffers from numerous erosion problems. Controlling erosion saves work in the long run, by preventing the build up of silt in river reaches, lakes, ponds, and the clogging of catch basin. It also significantly improves the appearance of the parks.

- Repair

  Park features, such as benches, trashcans, catch basins, soft surface paths, - which are easy to overlook and make a second priority—need regular maintenance.

In the Muddy River park areas, meeting higher standards includes not only the existing park areas but also the new planting that will be provided as a result of this project. Table 8-5 summarizes the increase in planting anticipated from the Muddy River Rehabilitation Project.

Table 8-5
Increased Planting from Muddy River Restoration Project

Project	***Trees***	***Low Shrubs (sq.ft.)***	***Medium Shrubs (sq.ft.)***	***High Shrubs (sq.ft.)***	***Lawn Areas (sq.ft.)***	***Wetland Plants (sq.ft.)***	***Perennial (sq.ft.)***
Wards Pond	1	2,425	2,875	1,750	8,350	2,360	1,625
Willow Pond	7	20,175	4,900	13,660	23,720	1,650	4,700
Leverett Pond	24	21,088	7,835	1,468	112,615	3,860	
Riverway	57	51,308	51,955	34,345	110,480	18,090	
Sears Parking Lot	28	7,700	3,050	5,400	25,200	1,260	
Back Bay Fens	98	24,635	59,515	34,450	389,100	32,330	
Total Trees	**215**						
Total (square feet)		**127,331**	**130,130**	**91,073**	**669,465**	**59,550**	**6,325**
Total (acres) 24.5		**3**	**3**	**2**	**15**	**1.3**	**0.15**

From ETM Associates, L.L.C.

Several ways were considered to characterize the increased standards. One approach was to consider the Arnold Arboretum as a standard of maintenance goal. The Arnold Arboretum clearly has a different focus than the project area where the Arboretum facility is not exclusively a public park and is foremost a research facility. Maintenance decisions are based on the Arnold Arboretum focus. Benchmark standards developed by the National Recreation and Park Association and the Professional Grounds Management Society were also considered in determining a target for the Muddy River in terms of higher maintenance standards.

ETM estimated the field hours required to maintain the park at current standards and the target higher standards. Table 8-6 summarizes the hours estimated for each category of maintenance in the project area.

A comparison between current staff capabilities and future required workload, based on the higher maintenance standards is included in Section 8.5 Staff Resources for Management and Maintenance. Recommendations for closing the gap between current capabilities and future needs are also included in that section.

Table 8-6
Summary of Hours Needed to Maintain the Project Area Parks

	Hours of Current Standards	***Muddy River Restoration Project Impact*****	***Total Hours of Higher Standards***	***Additional Hours***
General Maintenance	8,387	8,400	18,100	9,713
Horticultural Care	3,155	7,470	12,043	8,888
Repair/Preservation	1,562	1,868	3,011	1,449
Operations/Special Events		950	1,525	1,525
Totals*	**13,104**	**18,688**	**34,679**	**21,575**

* Totals are for field staff, and do not include supervisor or management staff.

** Included in Hours at Higher Standards

From ETM Associates, L.L.C.

8.4.2 Maintenance Guidelines

Improved maintenance in the Project area will be dependent on paying attention to the routine maintenance activities required in each type of park resource area. In the past, only selected activities were completed due to staff levels or skills. To meet the higher recommended maintenance standards, ETA detailed a list of all activities that need to be completed by the maintenance staff. These activities are listed below for each park resource (more thoroughly described in Appendix J) and this listing of activities would form the basis of a maintenance manual to be developed by the maintenance staff.

Planted areas (shrubs and perennials) – Watering, fertilizing, mulching, pruning, pest control, winter protection, use of ground covers, and integrated pest management are all activities that need to be performed on a regular basis for successful maintenance.

Erosion should be identified on a frequent basis and plantings can be used to control and prevent further erosion. Eroded areas need to be stabilized as soon as possible so they do not get larger and compacted so that plantings do not take hold.

Turf – Mowing, fertilizing, liming, aeration, turf renovation, and weeding are regular maintenance activities. Watering is obviously an important consideration, including where supplemental watering is needed for newly planted areas. In most areas natural watering is sufficient unless there are particular drought or local conditions where supplemental watering is needed for successful turf growth.

Erosion should be identified on a frequent basis and turf can be used to control and prevent further erosion. Eroded areas need to be stabilized as soon as possible so they do not get larger and compacted so that turf does not take hold.

Water bodies – Routine maintenance activities include trash removal, removing water borne vegetation, removal of invasive growths and monitoring water quality.

Water quality will be monitored as part of the larger project area issues and these activities are describe later in this section.

Invasive control will be a critical element of maintenance in the Project area by virtue of the problems it has caused to date. There are several general species of invasive plants that are a problem in and along the Muddy River. These are the giant reed grass (*Phragmites australis*), Japanese knotweed (*Polygonum cupidatum*), glossy buckthorn (*Rhamnus frangula*), greenbiar, Norway Maples, Ailanthus Altissima. *Phragmites* is a wetland plant and is growing in very large mats in the water as well as on the banks. The Japanese knotweed and glossy buckthorn are upland plants that may, however, be found in the wetland buffer zone, but are not classified as wetland species.

The initial approach to the control of the invasive vegetation is a component of the capital project and involves an initial large-scale removal through mechanical means that include dredging, excavation, cutting, and hand pulling. Following this initial removal, control procedures will change to a combination of cutting, hand application of the State approved herbicides for invasive control, and hand removal. Use of herbicides will be subject to public review.

- The proponents anticipate using experienced contractors for the specialty work of herbicide control of invasives. Personnel/contractors who conduct the application of herbicides must meet the following minimum requirements of the MA Pesticides Control Act (M.G.L. ch 132(b):
- Be insured as required by the DEP;

- Be Licensed by the State Pesticides Bureau of the MA Department of Food and Agriculture; and

- Use safest practices practicable.

Trees – Pruning, fertilization and protection from damage are the most important maintenance steps for park trees. Park staff must be trained to identify problems and trends and correct problems before they impact the health of the park trees.

Site furnishings – Maintenance activities vary for site furnishings in the park. The more important activities include bench maintenance (repair, replacement, and painting), trash can emptying, replacing lights and maintaining light poles, maintain drinking fountains (cleaning, repair turning on and off), and graffiti removal. These activities should be standardized in various park areas so that the sense of a single park is reinforced.

Woodlands – Maintenance in the woodland areas will be a more long term activity and should be driven by a woodland management plan. By working in selected areas, invasive species should be removed, reestablish the under story area and plant additional trees where the canopy area needs to be filled in. Trail maintenance and erosion control are two other important maintenance activities that need to be planned on a routine basis.

Historic park structures, features such as bridges, shelters and monuments, require special maintenance skills, maybe even requiring historic preservation skills. Training of a multi-skilled crew in traditional carpentry and masonry skills can make these maintenance activities more efficient than single-trade crews.

8.5 Resources for Management and Maintenance

The purpose of this section of the Management and Maintenance Plan is to identify resources that are available for the management and maintenance of the Muddy River park areas and to identify the resources necessary to provide a desired level of maintenance to the park areas.

In both municipalities and the MDC, the maintenance responsibilities have been placed under the direction of the Directors of Maintenance (superintendent or operations manager) who is responsible for all aspects of maintaining the respective parts of the Emerald Necklace. The superintendent has foremen responsible for specific segments of the park system. In order to increase maintenance standards additional staff and resources will need to be integrated into a management structure

8.5.1 Staff

The first step in assessing the staffing required for park maintenance is to determine the current staffing levels and the workload this staff level can support. Measuring workload is a complex task subject to many variables. Considerations such as amount of work, quality of work, frequency of tasks, and time to complete all enter into determining workload.

The process to measure current maintenance work included interviews, observations, and information provided by the three municipalities. The following is an outline of the methods used by ETM.

- Interviews were conducted with senior staff and field staff of the three agencies to elicit information on current staffing and operations.
- Review of existing organizational charts and work schedules.
- Site walks and park tours, including a walk with CAC members on August 4, 2001.
- Interviews with members of the Citizens Advisory Committee.
- Interviews with the Emerald Necklace Conservancy.

Full time equivalents (FTE) were developed to reflect the actual percentage of time maintenance staff spent in the Project area of the Emerald Necklace. A full time equivalent is equal to the work hours by a single employee (2080 per year). It is used to express total time of several employees that work part time on a given project.

- BPRD: Region 5 crew of 4 spends approximately 80% of it's time in the Project area of the Emerald Necklace which equates to 3.2 FTEs, while the Parkman horticulture crew of 3 spends abut 40% of its time or 1.2 FTEs. Boston maintenance staff is augmented by 1.1 FTE of supervisory support, including the Director of Historic Parks (50%), Historic Park Landscape Architect (20%); Parkman Funds contract Project Manager (40%).
- Town of Brookline; Two zone maintenance crews of 4 persons each spends 25% of its time in the project area or 1.15 FTE, while Forestry spends .1 FTE, Brookline maintenance staff is augmented by .6 FTE supervisory support and Arborist (5%), Operations Manager (10%) and Landscape Architect (5%).
- MDC; MDC maintenance crew of 4 persons from the Charles District spends approximately 25% of its time in the project area, which equates to 1.0 FTE, which is supplemented with supervisory staff equal to .1 FTE.

The estimated current staffing for work in the Project area by maintenance field staff and supervisors is shown below in Table 8 - 7.

Table 8-7
Current Full Time Equivalent Staff Project Area

Organization	*Work Force*	*Managers/ Supervisors (FTE)**	*Workers (FTE)**
Boston	M & O	.3	3.2
	Horticulture	.4	1.2
	Forestry	.1	.3
	Trades	.2	1.2
Brookline	M & O	.5	.75
	Horticulture	.25	.4
	Forestry	.25	.1
	Trades	.1	.25
MDC	M&O	.1	1
Total	**10.6**	**2.2**	**8.4**

*FTE = Full Time Equivalent M&O Maintenance & Operations
from ETM Associates, L.L.C.

The next step in evaluating the workload of existing staff is to determine the productive work time of the staff. This process consisted of taking the total time available to the 10.6 full time equivalent staff and deducting time not contributing to the work task. Deductions and lost time include holidays, vacations, absences, breaks, sick leave, Family Act Leave and leave without pay. Non-productive time includes time spent away from the work such as travel time to sites, trips to the dump, changing and washing up, and waiting time for vehicles or equipment for a task. Lost time due to inclement weather also detracts from the productive time on tasks. The net productive time is approximately 75% of the available time to staff. On this basis the total productive time available to the Boston, Brookline and MDC staff amounts to approximately 16,500 hours per year.

A comparison was made to the maintenance requirements at the higher standard of maintenance and a total additional staffing requirement was estimated. Table 8 - 8 summarizes the additional staff needed by community to meet higher maintenance standards given the additional areas of maintenance resulting from the rehabilitation project. These additional maintenance needs are broken down by municipality or entity.

The total number of additional hours needed by each municipality or entity to achieve higher maintenance standards for their portion of the project area is:

Boston	13,600 hours = 8.7 FTE's
Brookline	3,300 hours = 2.1 FTE's
MDC	4,700 hours = 3.0 FTE's

Table 8-8
Summary of Additional Hours for Each Entity

	Hours at Current Standards	***Additional Hours Needed***	***Hours at Higher Standards***	***Muddy River Restoration Project Impact***
General Maintenance	**8,387**	**9,713**	**18,100**	**8,783**
Boston	5,368	6,216	11,584	5,621
Brookline	1,426	1,651	3,077	1,493
MDC	1,594	1,846	3,439	1,669
Horticultural Care	**3,155**	**8,888**	**12,043**	**6,998**
Boston	2,019	5,689	7,708	4,479
Brookline	821	1,226	2,047	1,190
MDC	315	1,973	2,288	1,329
Repair/Preservation	**1,562**	**1,449**	**3,011**	**1,035**
Boston	1,200	727	1,927	662
Brookline	362	150	512	176
MDC	0	572	512	197
Operations/Special Events		**1,525**	**1,525**	**656**
Boston		976	976	420
Brookline		259	259	112
MDC		290	290	124

Totals are for field staff and do not include supervisory or management staff
From ETM Associates, L.L.C

Staff should also receive sufficient training to meet the demands of a dedicated maintenance crew. A dedicated training program for first level supervisors in supervision of staff and volunteers, communication, computers, personnel and work rules and CPR should be a high priority. Workers should be cross-trained to develop teamwork and taught horticulture, communications and CPR.

8.5.2 Equipment

An equipment acquisition and replacement scvhedule should be developed to mirror the increase in staffing for maintenance. Even well-equipped crews need to replace equipment is it wears out and new more effective equipment becomes available.

The maintenance staff should consider small electric or gas powered vehicles and mini-pickups to improeve operational effectiveness. Smaller vehicles are more appropriate than full size for reasons of maneuverability, economy, ease of maintenance and more park-user friendly.

8.5.3 Closing the Gap

We estimate that about 35,000 hours will be needed annually to maintain the project area at higher standards. The Muddy River Restoration project alone will require about 17,500) hours annually to maintain the restored landscape. Most of the added hours for maintenance will be needed beginning in 2006. The MDC will be faced with increased maintenance in the Charlesgate project area in early 2005; Boston will assume increased maintenance responsibilities beginning in early 2006 and Brookline in early 2008.

The estimated gap between needed and available productive hours is estimated to be between about 21,600 hours, which equates to 13.8 FTE's. Strategies for closing the gap should begin as soon as possible and not wait until capital projects are completed. The proponents have already begun to implement some of the recommendations, including joint training for Boston and Brookline staff at the Arnold Arboretum to increase staff skills.

A number of management and maintenance recommendations for improving maintenance and raising maintenance standards can be implemented. Many of these can begin now, don't increase existing operating budgets, and will improve current conditions as well as setting the stage for future improvements.

The shorter term strategies consist of improving organization of staff, definition of maintenance needs and activities, use of volunteers and improved training. This is relatively low cost and targets getting better productivity from current staff. In the medium term strategies, management, organization, standards and training are continued to be refined. Also in the medium term, more volunteers are targeted as well as hiring a small number of new staff. Connections with other organizations to help contribute to maintenance are also encouraged in the medium term. Over the longer term, once the affects of training, management improvements and organization changes are understood then more staff can be hired with a better understanding of minimum needs. Hopefully, in the longer term, volunteers and cooperation with other organizations such as the Emerald Conservancy will minimize the need for direct new park hires.

Short-term Recommendations (years 0-2)

- The project area parks should be managed in such a way that the public experiences the system as one park. Role of park coordinator should be implemented or coordination agreement should be established to coordinate park-wide maintenance among three entities to initiate geographic (park-wide) accountability.

- Develop selected park-wide maintenance standards for maintenance tasks such as mowing, bench repair, and horticultural maintenance for new plantings. Park-wide mowing standards should include a mowing cycle, trimming standards and maintenance of park benches.

- Form dedicated maintenance crew for the project park area.
  From existing park staff, identify and form a Muddy River Parks maintenance crew. Initially, existing park staff would be used to form such a crew Park maintenance staff would remain on their respective municipal payrolls.

  - Develop and implement joint training sessions.
  - Coordinate mowing schedules and practices.
  - Develop joint "3 x 3" projects wither resources from Boston, MDC and Brookline area combined for a cleanup or horticultural project in a specific area of the park lasting one to three days.
  - Identify projects such as graffiti removal on trash cans; set standards and completion dates.

- Strengthen the role of the Emerald Necklace Conservancy. The City of Boston, Town of Brookline, MCD should make every effort to provide information and support to the Emerald Necklace Conservancy's in its fundraising and programmatic efforts.

- Develop a two-year park-wide tree removal and pruning plan approved and funded by the City of Boston, Town of Brookline and the MDC using outside contractors.

- Schedule two (spring and fall) park-wide clean-up days involving Boston, Brookline, MDC, and volunteers.

- Develop and implement joint winter training program

Medium-term Recommendations (years 3-5)

- Expand park-wide maintenance standards to include horticultural tasks.

- Investigate options for a park-based maintenance facility.

- Rotate Park Coordinator or update coordination agreement.

- Park coordinator and project manager to coordinate horticultural construction/construction maintenance and ongoing park maintenance.

- Continue to support and develop Emerald Necklace maintenance crew.

- Develop Muddy River Parks joint operating budget.

- Purchase small electric or gas vehicles for park maintenance.

- Continue and expand tree removal and pruning contract.

- Develop park-wide tree replanting plan.

- Investigate additional maintenance tasks suitable for contracted services.
- Develop park-wide trash plan and standardized receptacles.
- Increase use of volunteers by 25%.
- Continue to support and strengthen role of Emerald Necklace Conservancy.
- Add 3-4 skilled horticultural staff.
- Continue and expand joint training to include new horticultural tasks

Long-term Recommendations (5 –10 years)

- Develop and implement plan to meet increased maintenance needs resulting from the Muddy River Restoration Project.
- Expand joint horticultural training.
- Increase use of volunteers by 75%.
- Add 3 skilled horticultural staff.
- Add 2-3 new maintenance staff.
- Increase funding for tree maintenance particularly replanting efforts.
- Eliminate Landscape Construction Supervisor position (later years)

8.6 Management and Maintenance Recommendations

8.6.1 Management Recommendations

Irrespective of the final management structure selected for the Project area, certain decisions need to be made to improve the management and maintenance of the park. The following recommendations are to be incorporated into whatever structure is formed.

1. Reestablish the primacy of maintenance in the Muddy River Park - The staff skills and management of the Muddy River Park must be upgraded to improve the level of maintenance in the park. Creative and flexible management strategies will need to be implemented to restore and maintain the future Muddy River Park.

2. Maintenance and management structure should be geographic-Muddy River Park is an important cultural resource and living system. Staff training and ownership can raise the commitment to park maintenance when staff are focused on a single geographic area. The maintenance and management structure should develop strategies to keep staff focused as much as possible by geographic area and be sure no areas of park maintenance are neglected.

3. Develop a focus for park maintenance – Close coordination in maintenance will be necessary to deliver consistent services to the park. This coordination could be accomplished with a single rotating coordinator or formal coordination agreement between communities. The coordination function would provide a report to the governing organization summarizing part maintenance and raising critical issues that need to be addressed.

4. Improve landscape construction supervision – Many maintenance problems are the result of improper construction practices. Storage of materials too close to trees, damage caused by vehicle traffic and careless excavation are all preventable examples of construction practices that damage park landscape. Construction supervision needs to be upgraded through training, use of consultants or designating a member of the staffs to serve as project manager. The skills of the project manager need to recognize proper planting specifications and quality of plant material to be used.

5. Consider park based maintenance – Park based maintenance can improve efficiency of existing crews by reducing travel time. Equipment can also be downsized if travel and usage is reduced.

6. Strengthen and define roles between public and private sectors – The relationship between public entitles owning and operating the parks and private sector constituents like the Emerald Necklace Conservancy are in there infancy. The relationship needs to be further developed, resulting in an overall stronger park advocacy.

8.6.2 Maintenance Recommendations

1. Promote efficiency in maintenance – management body needs to support consistent and higher maintenance standards and practices. Enhanced training and efficient assignment of staff can increase overall efficiency of maintenance.

2. Reestablish primacy of maintenance the Project area – Reestablish basic park maintenance skills as primary staff responsibilities. Recover lost maintenance skills through higher horticultural standards, developing woodlands management and specialized water body management.

3. Implement park wide maintenance standards, practices and guidelines.

4. Adopt a seasonal organizing structure for park maintenance – Unlike other public organizations operating on a fiscal or calendar year basis, parks need to be based on the growing season. A suggested seasonal breakdown of "Winter" (December– February), "Spring" (March – April),"Summer" (May-September) and "Fall" (October – November). Maintenance, planning and training activities should be tied to this cycle.

5. Consider adopting dedicated park based maintenance crews.

6. Develop a tree maintenance and replanting plan – Active management of the character defining mature deciduous trees needs to be implemented through regular pruning, disease management and selective removal. Also develop consistent replanting scheme to regularly replant from a list of historical and ecological importance.

7. Develop a woodland management plan – Beginning with an advisory committee develops a comprehensive plan for woodlands. Consider use of volunteers and a forest management team to critically intercede in the woodlands.

8.7 Monitoring and Maintenance Practices – Culverts and Best Management Practices

As new culverts are constructed under the project, monitoring and maintenance will be required to assure the facilities operate at full capacity to pass storm flows.

Once new BMPs are implemented and existing BMPs are improved, a monitoring and maintenance plan must be followed to evaluate and ensure the effectiveness of the BMPs and to reduce the need for future capital costs. For new structural BMPs, maintenance involves inspection and cleaning at regular intervals. If proper maintenance is carried through, the project life of the new systems can be maximized.

8.7.1 Culvert Maintenance

Existing culverts in the project area are maintained by BWSC, Brookline Public Works Department or the MDC. The proposed project improvements will not change this arrangement and will probably lower maintenance requirements through improved design.

Culvert maintenance consists of two major activities; clearing accumulated debris or sediment and repairs to the structures. In Section 8.6.1 preventative inspections prior to major storms are described. This type of inspection should also occur twice per year outside of specific storms. When blockages are discovered they should be cleared.

One time per year the culverts should be inspected for structural conditions to be sure no cracks, erosion, or settlement has occurred that may compromise the operation of the culvert.

In the future, Boston and Brookline will be responsible to maintain all culverts in the park area except those under the MDC roadways.

8.7.2 Maintenance of Source Control BMPs

The source control BMPs discussed in Section 5.6 all require some level of maintenance. One example is the correction of curb settings to prevent erosion along the banks and sedimentation of the eroded material in the Muddy River. Once the foundation for the MDC roadway and curb is repaired, regular maintenance is required to prevent additional erosion and to prevent large capital expenses in the future. Periodic inspection by the MDC is recommended to determine if erosion or settlement has re-occurred and what needs to be done for repairs. These repairs would be an annual project to be considered by the management.

With the new catch basin cleaning and maintenance program, BWSC will have a more comprehensive database including information such as the location, structural integrity, and sediment deposition rate of each catch basin. This should streamline the cleaning and maintenance processes and make it easier for crews to clean catch basins as part of a regularly scheduled program. An important component of Boston's new catch basin database is to keep it updated by documenting in the database when new construction occurs such as when catch basins are paved over or new catch basins are added.

As part of the recommended BMP maintenance program, Brookline should continually update its database with the condition of the catch basins, which would help the Town develop a regular catch basin cleaning program. Since the MDC currently has no formal funded catch basin cleaning program (and no comprehensive catch basin database) it is recommended that both the database and a regular cleaning program be developed for the MDC as part of their BMP maintenance requirements. As recommended in Section 5.8, the MDC should reconstruct some of their stormwater drainage system and once the construction is over, inspection, monitoring, and frequent maintenance can prevent future reconstruction.

Maintenance of the street sweeping programs is another key component in an effective long term BMP program for the Muddy River watershed. Annual budgets must factor in maintenance costs and the costs of new trucks and equipment for street sweeping. Boston and Brookline will be the responsible for streets they own in the watershed. The MDC is also recommended to augment their existing street sweeping program and provide sufficient budget to complete this activity.

Once the desire lines are corrected in the Riverway and the Back Bay Fens, the maintenance program should include trail maintenance as needed. Replanting of grass and vegetation every spring or fall would prevent large efforts every couple of years and will provide an overall aesthetic experience for park users. Maintenance of desire lines would fall under the same responsibility lines as the park maintenance.

A final recommended maintenance measure for source control BMPs is public education. The sections of Boston and Brookline which abut the Muddy River are, in many cases, transient. The population changes frequently. An ongoing public education program covering all aspects of source control BMPs is needed to ensure current and future residents understand their role in protecting their waterways and prevent potential flooding problems. As mentioned in Section 5.7, ongoing public education efforts should include information on herbicide and pesticide use management, proper disposal of litter, pet wastes, and household hazardous materials. The public education program costs should be split by contribution to watershed as identified in Section 5.9.

8.7.3 Maintenance of Treatment Control BMPs

Vegetated Swales

Maintenance requirements for vegetated swales included regular mowing of the grass, no shorter than twice the design flow depth (typically 4-6 inches). Swales should also be inspected monthly to check for inlet plugging and signs of erosion. If erosion is occurring, stabilization of eroded side slopes and/or bottom is necessary. It is necessary to keep swales free of debris. Damaged areas should be reseeded as soon as possible. Several seasons of planting and re-seeding of sparsely vegetated areas may be needed in order to reach optimum performance (EPA, 1999). Other maintenance requirements for grass swales include de-thatching swale bottom and removal of thatching, discing or aeration of swale bottom, and nutrient and pesticide use management. Also, every five years proper maintenance requires scraping the swale bottoms and removing sediment to restore the original cross-section and infiltration rate. Currently only one swale is contemplated at the Victory Gardens which would be maintained by BPRD. If more swales are installed, then the land owner would maintain the facility.

Particle Separators

For the particle separators that are considered as the recommended alternatives, seasonal inspections are recommended for the first year of operation to establish an appropriate maintenance schedule. Thereafter, the system is cleaned annually depending on weather and site activity; however, for installations in New England, it is recommended that the systems be cleaned just prior to the winter salting and sanding season. Responsibility for maintenance would fall to the owner of the outfall.

Sedimentation Basins

Sedimentation basins, formed by overdredging, require monitoring for sand bar formation every year. The programming for maintenance dredging should be started when the sedimentation has accumulated to approximately 50% of the basin's initial capacity. In order to preclude the downstream migration of sediments, the maintenance dredging should be schedule when the basin reaches 50% of capacity.

Basin shapes and depths will be measured at the end of the construction. Once per year, a grid will be set up to measure sediment depths at each basin and estimate remaining basin volume. This activity could be conducted by either Boston or Brookline or contracted to a third party. Costs should be shared based on the percent of watershed for Boston and Brookline.

Permitting and construction activities for maintenance dredging would be shared by watershed parties and probably contracted to a third party. Since maintenance budgets would be significantly impacted by this activity, it is likely to be a capital cost when needed and should be included in future capital budget plans.

8.7.4 BMP Monitoring/Maintenance Logs

As each BMP is constructed or implemented, the owner of the BMP will prepare a monitoring/maintenance log. The logs will document the monitoring/maintenance activities described in 8.5.1 and 8.5.2. These logs will be submitted as part of the Annual Update Report to MEPA.

The log should consist of a list of the maintenance activities for each BMP including scheduled inspections. A supervisor should initial and date each activity when it occurs. The logs should also include non-scheduled activities that may occur for each BMP.

In the case of catch basin cleaning programs, once the database is generated, a summary of the activities can be reported.

8.8 Corrective and Maintenance Measures Following Specific Storm Events

This section of the Management and Maintenance Plan contains a description of preventative, corrective, and emergency actions that are to be conducted preceding, during and following a storm event of a specific magnitude.

Responsibility for preventative and corrective measures would be shared by BPRD, BPOSD, and the MDC. Each agency would be responsible for river segments within their boundaries and culverts under their roadways. BPRD would report maintenance needs to BWSC and BPOSD to Brookline Department of Public Works.

8.8.1 Preventative Measures

Preventative measures prior to large storms should include staff walking along the River doing visual inspections and removing trees or other debris that are blocking culvert or bridge openings. For example, as a result of large storms in the past, significant erosion has occurred due to blocked drains or catch basins. Preventative measures including visual inspections during large storms could limit this type of erosion in the future.

8.8.2 Corrective Measures

In addition to regular maintenance measures in the Muddy River watershed, specific corrective measures need to be undertaken following storms of expected to exceed 4 inches in 24 hours. These corrective and maintenance measures include removing debris from culverts and bridge openings as well as catch basin and storm drain cleaning. Although the catch basin cleaning programs currently being implemented by BWSC and the Town of Brookline should include provisions for these measures following storm events. It is very important that catch basins that typically experience backup in large storms are inspected and if necessary cleaned immediately following large storms to remove sediment that has been deposited during the event. In general, catch basins would be expected to operate through storm events and collect debris, however, particularly large events may impact catch basins more than normal storm events and should be checked.

Correction of eroded stream banks and pedestrian trails should also be completed following storms of large magnitude to prevent further erosion. An maintenance form should be completed when correcting eroded banks and trails caused by large storms, based on a routine maintenance and inspection form. Removing debris, including fallen tree branches and litter carried by the storm, is another important corrective measure that must be undertaken by all three entities following large storms.

8.8.3 Emergency Action Plan

A major emergency action plan was developed through cooperation of numerous entities to prevent potential flooding of the Muddy River. The Interim Interagency Plan outlines the steps taken by the MDC, the City of Boston, the Town of Brookline, and the MBTA to prevent flooding of the River in the vicinity of the MBTA Green line. As flood improvement facilities are constructed as part of this project, the level of flooding and back-up issues are expected to be reduced. This plan should be modified once these facilities are completed and experience with new storms shows a new level of maintenance/operational needs. The current plan includes four stages, as outlined in the following paragraphs.

Stage One: The Alert

National Weather Service (NWS) locates a storm that poses a potential flood threat to Southern New England.

Metropolitan District Commission Charles River Dam (MDC) institutes "Standard Operating Procedures for Hurricanes and Storms" (1977).

Boston Parks & Recreation (BPR), Boston Water & Sewer Commission (BWSC) and Brookline Water & Sewer (BRKWS) notify personnel to be on alert for possible staffing, and they monitor NWS advisories.

The Mass Bay Transportation Authority (MBTA) shall institute "Standard Operating Procedure: Muddy River Flood Control (1997) (SOP).

BPRD checks water level in Jamaica Pond, and closes baffles between Jamaica Pond and Wards Pond.

Stage Two: The Warning

NWS forecasts heavy rainfall to occur within six hours in the Boston area and issues a Severe Storm Warning.

MDC begins 24 hour staffing.

BWSC staffs up, opens the gate at the Brookline Ave. Gatehouse to allow the Muddy River to follow its natural course through the Back Bay Fens and through the Muddy River Diversion Conduit.

MBTA dispatches crew to monitor water levels in the Riverway at the culverts, and is prepared to install drop-log dams.

Stage Three: The Operation

One inch of rain has fallen within 3 hours and heavy rain is forecast to continue.

MDC continues to monitor rainfall and maintain river levels according to their SOP.

BWSC dispatches crane to the culverts.

Pooling in the Riverway begins, with water level reaching 110′ MDCB (10′ BCB or 4.45 NGVD).

BWSC crane removes trash grates over culverts.

MBTA suspends trains on "D" line, and installs both drop-log dams.

BRKWS dispatches crew to Brookline Avenue field to monitor access chamber covers to Tannery Brook Drain for movement, indicating surcharge possibility.

Flood water on the tracks. Preparation ends, the battle is joined.

Stage Four: Cessation of Event

NWS advises that the storm has passed. Operations continue until flood threat is over and water levels recede.

This plan also includes an Emergency Notification Form which lists the agencies involved in the Action Plan and the appropriate contact individuals in each agency.

8.9 Pest and Rodent Control

This section deals with the necessity for controlling such pests as ducks and geese, as well as rodents. In the past several decades, the annual migration of ducks and geese has changed to the extent that these birds remain in many northern ponds and rivers because of the abundance of food from persons feeding them. The ducks and geese have become a particular nuisance because of their continued presence on the banks and surrounding land where they have denuded the ground cover. Feces also impart large quantities of bacteria and nutrients, two water quality constituents that are not needed in already enriched urban runoff waters.

Proactive measures need to be taken to reduce the numbers of ducks and geese in the Muddy River. These may include:

- Public Education;

- Local ordinances against the feeding of ducks and geese (which may involve local agencies such as Boston Inspectional Services or Brookline equivalent);
- The planting of suitable plant species that will form a barrier between the water and land; and
- The implementation of reproductive controls on the goose population by state and federal game officials.

As each of these elements are implemented under the Management Plan, a review of the effectiveness should be undertaken as part of the Annual Update Report and recommendations made for modifying the program as needed. Responsibility for this program cost will be shared by Boston and Brookline based on watershed areas. The MDC is recommended to participate in this activity also based on their share of the watershed area.

8.9.1 Local Ordinances and Public Education

The urban public is as attracted to the flocks of ducks and geese in parks as are the birds to the public. This condition, however, is counterproductive to water quality and ecological stability as well as it is an unnatural intrusion to the bird's instincts. Increasing numbers of municipalities are adopting ordinances against the feeding of ducks and geese to control their population.

Boston and Brookline should consider the adoption of an ordinance against the feeding of ducks and geese, at a minimum at specified locations. The New England Aquarium has sponsored an annual Fresh Water Fair at Leverett Pond. One of the displays could be used to educate the public and to provide pamphlets that inform the public of the problems that are created by the feeding of the geese. Signs will also be posted prohibiting the feeding of geese. However, until there is a local ordinance, there cannot be any enforcement. Periodic notices will published in the local edition of the TAB and other newspapers.

8.9.2 Planting of Natural Barriers

The Preliminary Design Report in Appendix I contains specifications for the planting and maintenance of a vegetative barrier to prevent waterfowl from walking onto the land. Such barriers are the most effective means to control the congregation of waterfowl yet they must be maintained.

The vegetative barrier is most effective because it combines an effective barrier with aesthetic qualities. Vegetative barriers need to become fully established to be effective so maintenance is important until the plants become established. Brookline has used mesh fencing as a temporary measure until plantings are established.

8.9.3 Implementation of Controls

Requests will be made to the Massachusetts Division of Fisheries and Wildlife and the U.S. Fish and Wildlife Service to provide their assistance in controlling the reproductive success of the geese. The control simply involves the spraying of the eggs with mineral oil which does not allow the eggs to hatch. It may be necessary to repeat the control several times each year.

8.10 Monitoring and Inspections

8.10.1 Water Quality Monitoring Plan

During preparation of the Muddy River Environmental Impact Report (EIR), the water quality of the Muddy River was tested during dry and wet weather events. The monitoring resulted in the finding exceedances of the DEP Class B Water Quality Criteria for percent oxygen saturation at the Longwood Avenue Bridge (dry weather conditions), pH in the Daisy Field Drain (first wet weather sampling event - October 6, 2000), and fecal coliform and fecal streptococcus coliform bacteria (during each sampling event) at several locations within the Muddy River system. Based on those data it was recommended that long-term monitoring be conducted as follows.

An annual water quality sampling program consisting of quarterly (seasonal) sampling events. The sampling will be conducted at the following locations:

Within the Muddy River	***Drainage Outfalls***
Commonwealth Avenue	Emmanuel College Drain
Agassiz Road	Longwood Avenue Drain
Boston Gate Houses	Tannery Brook Drain
Fens Bridge	Huntington Avenue
Longwood Avenue Bridge	Village Brook Drain
Outlet of Leverett Pond	Daisy Field Drain
Outlet of Willow Pond	Chestnut Street Drain
Outlet of Wards Pond	

The Town of Brookline and the Boston Water and Sewer Commission are independently conducting investigations into conditions within the above drainage outfalls to determine potential sources of non-domestic sewage nutrients.

During each quarter, water quality samples will be collected during a dry period (no rainfall in the past 96 hours), during precipitation, and the day following a precipitation event. The rationale behind this frequency of sampling is to obtain seasonal data preceding precipitation (rain or snow), and to monitor the impact to water quality during and after an event. Therefore, in any given year, up to 12 sampling events will occur at each sampling location.

Samples shall be collected and analyzed by a qualified laboratory for the following parameters:

Sample Parameters	
Fecal Coliform Bacteria	Turbidity
Fecal Streptococcus Coliform Bacteria	Alkalinity
Total Suspended Solids (TSS)	Acidity
True and Apparent Color	Ammonia Nitrogen
Total Phosphorus	Nitrate-Nitrite Nitrogen
Orthophosphate Phosphorus	Metals
	TPH-EPH

Field monitoring for pH, temperature and dissolved oxygen should also be conducted during all sampling.

Data from this monitoring program can be used to monitor the water quality as related to meeting DEP Class B waters and also progress towards reducing sediment loads on the basin. This program is also an excellent candidate for local universities and interest groups to participate as part of educational programs.

The water quality monitoring program is recommended to determine in a coordinated manner the overall health of the water system. Several agencies and organizations are already gathering data for different but similar purposes and if the collection and analysis were coordinated the overall costs could be reduced and quality and usefulness of the data increased. Boston and Brookline would share the cost of the water quality monitoring based on watershed area. The MDC is also recommended to share in this cost on the basis of watershed area. There are several other sources of funding that should be investigated such as state agencies, private groups and universities. University study programs can be used for teaching and source of sample collection and analysis that may be useful for the program. Volunteers like the Charles River Watershed Association may also contribute to this effort.

8.10.2 Observations on the Growth and Success of Shrubs, Wetland and Other Habitat Plantings

One of the requirements for the construction project, as presented in the Environmental Notification Form (Jan. 1999) Phase I of the Muddy River Flood Control, Water Quality and Habitat Enhancement, and Historic Restoration Project, was that Boston and Brookline will maintain the historic and habitat plant materials. In order to fulfill this requirement, it will be necessary for Proponents to develop a report on site inspections made one, three, and five years after planting to assess the success of the effort and to reevaluate and adjust planting efforts as required. Once this inspection program has been established it should then continue on a three year cycle in order to insure the health of these plantings in the future and reported in the Annual Update to MEPA.

The proposed plantings will provide historical restoration, rehabilitation or preservation, improvement of habitat, and increased bio-diversity. In addition, they will provide a practical, sustainable, historical, and ecologically sensitive solution that needs to function within the management and maintenance capabilities of Boston and Brookline. Many factors can effect these new plantings. Competition from existing plantings, spontaneous invasive vegetation crowding them out, lack of water and nutrients, or light conditions not being optimum due to over-shading are all factors to monitor and record. After planting new trees, the existing tree canopy needs to be continually monitored and pruned annually to encourage better development of the new plantings. Understory plantings also need to be considered when crown thinning and tree clearing.

Also in regard to the historic and habitat plantings, the success rate of the program to control the host of invasive species that are currently overgrowing the Muddy River, such as *Phragmites*, Japanese Knotweed Glossy Buckthorn, Bittersweet, Purple Loosestrife, etc. must also be monitored and recorded. Allowing even a small amount to regenerate will mean that the desirable plantings will quickly be invaded and overwhelmed by these species. Park employees should be trained to identify invasives. This should be done 3 times per year and document where invasives have started regrowing. For procedures on the management of invasive vegetation, see Section 8.4.2. Responsibility for this activity would rest with the park owner.

8.10.3 Monitoring of Fish and Wildlife Distribution and Reproduction

As the result of dredging of the Muddy River, the removal of *Phragmites*, enhancement of the wetland habitat and fish spawning beds; an improvement water quality and consequently in the species composition and distribution of indigenous fish is anticipated. This should be evidenced through the presence of more spawning nests for panfish and bass. Pickerel spawning could also be enhanced by placing brush piles underwater. The environmental enhancements to the Muddy River are also anticipated to result in the migration of greater numbers of the blueback herring to Leverett Pond. The blueback herring is an anadromous fish that migrates to fresh water to spawn. Eggs of the blueback herring sink and stick to anything they contact. Good sediment quality is very important for the survival of the eggs. Toxic or highly organic sediments are not as suitable as are relatively clean granular (sandy) bottoms. The young return to salt water within a few months of hatching.

In addition, the restoration of an indigenous plant community from the existing mono-typic species, will create a healthy ecosystem containing a variety of plant communities (i.e., diversity) ultimately resulting in the development of significant and valuable structural heterogeneity. This diverse habitat is preferred by a wide-variety of avian, mammalian and invertebrate species. Wading birds such as great blue heron, green heron and black-crowned night heron will take advantage of bank habitat. The interface or edge effect between terrestrial and aquatic environments (the ecotone) provides significant food sources, shelter, breeding and nesting areas for a variety of invertebrates including dragonflies, butterflies and beetles which in turn provide food sources for all growth levels (larval, pupa and adult) for avian and small mammal species. All these factors will result in the increase in wildlife species, notably birds.

It is important that any changes in the distribution and species composition of fish and wildlife be documented. The documentation of such changes will help fulfill regulatory requirements and will also add to the scientific data base on the Muddy River. It will also allow later comparisons to be made between the various community groups (i.e., aquatic water quality, sediment quality, and wetland shoreline and upland habitat. Every 2 years a biologist should visit the site several times in the early and late growing seasons to document wildlife use of the habitat. Responsibility of this activity would be split by ratio of watershed area.

8.10.4 Monitoring and Maintenance of Historic and Character Defining Features

One of the requirements for Phase I of the Muddy River Flood Control, Water Quality and Habitat Enhancement, and Historic Restoration Project, is that the Proponents will be required to maintain the historic and character defining features of the restored parks. In order to fulfill this requirement, it will be necessary for Boston and Brookline to develop a report on annual site inspections to assess the condition of these features and to reevaluate and adjust maintenance efforts as required.

The historic and character defining features include what the National Park Service guidelines call the character defining features, which under the National Park Service (NPS) guidelines would include:

- Spatial relationships;
- Views and vistas;
- Topography;
- Circulation systems and site entries;
- Vegetation;
- Water features; and
- Furnishings and structures.

The Master Plan for the Emerald Necklace Parks, Jamaica Pond, Olmsted Park, The Riverway, and the Back Bay Fens provides an invaluable resource for the stewards of the Emerald Necklace. The recommendations set forth in the document are intended to provide a framework for decision-making and to lay the groundwork for preserving, rehabilitating and restoring these features.

The work proposed in the EIR will provide historical restoration, rehabilitation or preservation, of the existing character defining features. The monitoring of structural integrity and conditions of historical features should be an ongoing process. Scheduling of rehabilitation or repair work for each of these historic features should be included in the annual budget as an estimated contingency item. Immediate issues should be reported by staff and if they are life threatening they should be repaired or stabilized immediately.

Monitoring and recording of the integrity of spatial relationships of features and the important views and vistas created by Olmsted's plant massings, topography and circulation system will ensure the continuation of their integrity into the future. This should be done in the fall and should be scheduled for winter or next spring's work. While not strictly an issue of historic and character defining features, monitoring the condition of the furnishings and structures including lighting, benches, trash receptacles, etc. is critical and will insure the continuation of their integrity. This should be done in the spring of each year and should be scheduled for that spring's work. Monitoring the condition of all paved surfaces and circulation systems should be done on a yearly basis in the fall and repairs should be scheduled for the next spring or for winter work.

Vegetation monitoring is discussed in Section 8.9.2 – Observations on the Growth of Shrubs, Wetlands and Other Habitat Plantings. This work should generally be monitored during the growing season and should be scheduled for work in the winter and in the next planting season.

Many of these features can be part of routine maintenance and can be projected each year based on past requirements. Some of this work, however, falls to specialized trades. For example the key trades involved in the management and maintenance of the bridges and buildings are masonry, carpentry, painting, lighting and plumbing, as well as, graffiti removal.

Inspection of these features should be scheduled on an annual basis. Immediate issues should be reported by the staff on a daily basis. Since specialized trades are required, these are not routine maintenance operations. The two exceptions should be graffiti removal, which should be removed immediately by parks personnel who are trained to remove it safely and vandalism, which also needs to be repaired immediately to reduce reoccurrence. Responsibility for this activity would rest with the park owner.

8.11 Maintenance Costs

The purpose of this section is to identify those costs that need to be provided to accomplish the Management and Maintenance Plan as outlined in this report section. Costs have been divided into the annual maintenance costs for the BMPs in this report and non BMP related maintenance costs. The BMP costs will not have to be provided until the BMP is actually constructed which may be after the main capital construction program. However the estimated cost to support all BMPs are include in this section.

The increase in labor recommended to meet increased maintenance standards is likely to be met with a combination of increased efficiency, volunteer staff, contract staff and new staff. Not knowing the exact mix of how this enhanced staffing will ultimately be met based on the results of management changes makes it difficult to estimate a dollar figure. For purposes of this report, we have taken the total future labor hours (in FTEs) and calculated a total maintenance value at an average labor rate of $30,000 per employee per year. A cost for equipment and supplies has been added since typically the labor is about 70 percent of total cost (from ETM). This total future maintenance value may be added in several ways. Part of these costs are already included in the respective budgets. Additional value will be gained through volunteers, better training, organization changes and possibly some new staff.

8.11.1 Annual Cost of Maintenance for BMPs

Annual operation and maintenance costs of watershed BMPs and treatment control BMPs are included on Table 8-9. Some of the programs are on a watershed wide basis and we have estimated the cost to be centrally administered and shared by the agencies on a watershed ownership basis. Where the activity is listed as a Boston or Brookline responsibility, the actual agency conducting the work will vary. In Boston for example, Boston Water and Sewer Commission, Boston Public Works Department or BPRD may actually be conducting the maintenance item. The BPRD will be coordinating the work and making these assignments through the City of Boston. In Brookline, maintenance activities will be shared by the Parks and Open Space Division, Brookline Department of Public Works and the Water and Sewer Enterprise Fund.

A total of $259,000 in annual operation and maintenance costs have been identified for BMP related maintenance items. Of this total, $96,000 is for maintaining the sedimentation basins in the river formed by over dredging. Annual maintenance for over dredging was calculated by estimating the cost of annual measurement of dredging accumulation and then the cost of removing the accumulated dredge material on a periodic basis. While this is considered an annual cost to the project since it is an accumulation occurring each year, this item may be addressed as a capital project under some of the agencies budgeting regulations. This being the case the $96,000 may not be appropriated each year but on a periodic basis as the need for dredging arises.

The catch basin cleaning program has been estimated as part of this section, however most of these costs are currently being included under other departments' budgets. In Boston, the Boston Water and Sewer Commission is cleaning all catch basins as part of their identification and cleaning program. At the end of this program, they will be determining the most cost effective cleaning frequency and providing agency resources on an annual basis to meet the recommended program. In Brookline, the cost of the catch basin cleaning program is already being born by the Department of

Best Management Practice (BMP)	*Responsibility*	*Type of BMP*	*Boston*	*Brookline*	*MDC*	*Total O & M*
Basin-Wide Source Control BMPs						
Annual water quality sampling program	Administered centrally with shared cost	Non-structural	$19,000	$50,000	$6,000	$75,000
Improved street sweeping program	Boston, Brookline, MDC	Non-structural	$9,000			$9,000
Catch basin cleaning program	Boston, Brookline, MDC	Non-structural	$25,000	$10,000	$6,500	$41,500
Trail maintenance	Boston, Brookline	Non-structural	$5,000	$5,000	$0	$10,000
Public education program	Administered centrally with shared cost	Non-structural	$1,500	$3,000	$500	$5,000
Waterfowl control program	Boston, Brookline, MDC	Non-structural	$500	$500		$1,000
Catch basin labeling program	MDC	Non-structural				
Review and strengthen park and stormwater regulations	Boston, Brookline	Non-structural	No new costs to conduct this program			
Back Bay Fens - Treatment Control BMPs						
Vegetated swale in Victory Garden	Boston	Structural	$400			$400
Particle separator at Emmanuel College Drain	Boston	Structural	$1,500			$1,500
Sedimentation basins in river	Boston, Brookline, MDC	Structural	$19,000	$50,000	$6,000	$75,000
Particle separator for MDC storm drains	MDC	Structural			$1,500	$1,500

Table 8-9
Summary of O and M Costs for Watershed BMPs

Best Management Practice (BMP)	***Responsibility***	***Type of BMP***	***Boston***	***Brookline***	***MDC***	***Total O & M***
Riverway - Treatment Control BMPs						
Sedimentation basins in river	Boston, Brookline, MDC	Structural	$2,000	$5,000	$1,000	$8,000
Leverett Pond - Treatment Control BMPs						
Potential particle separators or other treatment controls	Brookline	Structural		$15,000		$15,000
Particle separator at Daisy Field Drain	Boston	Structural	$1,500			$1,500
Sedimentation basins in river	Boston, Brookline, MDC	Structural	$2,000	$6,000	$1,000	$9,000
Willow Pond - Treatment Control BMPs						
Particle separator at Chestnut Street Drain	Brookline	Structural		$1,600		$1,600
Sedimentation basins in river	Boston, Brookline, MDC	Structural	$1,000	$3,000	$0	$4,000
	Total O &M Annual Budget		$87,400	$149,100	$22,500	$259,000

Table 8-9
Summary of O and M Costs for Watershed BMPs

Public Works and the programs enhancements include targeting catch basins needing more frequent cleaning based on past removal rates. The MDC on the other hand needs to implement an improved management program. While they currently clean catch basins there will have to be an upgrade to keep these facilities operating to prevent sediment from reaching the Muddy River.

8.11.2 Annual Cost of Maintenance for Non BMP Items

Several non BMP related maintenance items will require appropriations on an annual basis to meet the goals of the Management and Maintenance Plan. The infrastructure along the river will have to be maintained on an annual basis. In general terms we estimate the value of maintenance on these structures at about 0.5 percent of their capital value each year. This value has been applied to the new planned infrastructure as well as the existing infrastructure. In practice this cost can be borne in several ways. Annually the structures may require minor repairs such as painting, pointing of stone work or patching due to wear or damage. Small items can be accomplish under the operating budget. Certain organizations prefer to cover these costs as a capital cost for an improvement program every few years. As a result many of the infrastructure annual maintenance costs do not have to be appropriated every year depending on how the governing body proposes to fund repairs.

A cost for an annual cleaning program in the river to remove debris and trash accumulated from storms has been estimated.

A series of reports including the Annual Update Report for MEPA have been estimated in the annual operation and maintenance section.

Total BMP related costs have been added to the non-BMP related maintenance costs in Table 8-10 to present a total annual operation and maintenance cost including the park maintenance. The project proponents agree that the level of maintenance described in Section 8 is appropriate. The proponents will seek to fund this level of maintenance, subject to appropriation and the availability of funds. The proponents have already begun to address some of the maintenance recommendations. In recent months, Boston and Brookline have begun a joint training program for maintenance crews at the Arnold Arboretum. Boston has created an historic parks unit with a director, project manager for the Parkman Fund and assistant project manager. This unit works closely with partners in both the public and private sectors, in cooperation with BPRD's General Superintendent of Horticulture and city arborists. The Department has also reconvened it woodlands committee at the staff level. In Brookline, a recent shift to zone management resulted in a crew whose zone includes Brookline's portion of the Emerald Necklace. Both Boston and Brookline remain committed to closing the maintenance gap identified in Section 8.

Annual Operation & Maintenance Item	***Boston***	***Brookline***	***MDC***	***Total O & M***
Non BMP Infrastructure Maintenance Items				
Fens Bridge Maintenance			$4,000	$4,000
Brookline Ave Culvert Maintenance	$29,000			$29,000
Riverway Culvert Maintenance			$18,000	$18,000
Annual open channel inspections and cleaning	$6,000	$3,000	$1,000	$10,000
Existing brigde structures upstream of Sears rotary	$42,000	$42,000		$84,000
Existing brigde structures downstream of Sears rotary	$14,000		$55,000	$69,000
Other Annual Operation & Maintenance Items				
MEPA Annual Update Report	$10,000	$27,000	$3,000	$40,000
Report on plantings	$2,000	$7,000	$1,000	$10,000
Report on Aquatic and Wildlife Distribution	$2,000	$6,000	$1,000	$9,000
Report on Historic / Character Defining Features	$1,000	$2,000		$3,000
Park maintenance activities (maintenance value)	$665,000	$200,000	$175,000	$1,040,000
Total Non BMP Operation and Maintenance Costs	$771,000	$287,000	$258,000	$1,316,000
BMP Operation and Maintenance Costs	$87,400	$149,100	$22,500	$259,000
Total Operation and Maintenance Costs	$858,400	$436,100	$280,500	1,575,000

Table 8-10
Summary of O and M Costs

9

Section Nine

Section 9
Statutory and Regulatory Standards and Requirements

9.1 Overview

The planning approach for the Muddy River Project involves a multidisciplinary perspective that combines elements intended to meet the project goals of flood control, water quality improvement, aquatic and wetland habitat enhancement, and historic preservation. These project goals or objectives are described in Section 1. Where possible, project elements have been included which meet multiple goals in order to maximize the project benefits.

This section of the DEIR describes the regulatory requirements that apply to the Muddy River Project. First, a discussion of the overall project objectives and primary regulatory requirements are presented. Discussions of the permits required for Charlesgate and those required for the remainder of the project follow.

Primary regulatory programs that are applicable include the Massachusetts Wetland Protection Act (WPA) - Massachusetts General Law (MGL) Chapter 131, Section 40 and its regulations (310 Commonwealth of Massachusetts Regulations [CMR] 10.00), Section 106 of the Federal Historic Preservation Act, and Section 404(b)(1) of the Federal Clean Water Act.

9.1.1 MA Wetland Protection Act Interests and Regulation 10.53(4)

The MA WPA has eight statutory interests upon which the regulations are built: Public and Private Water Supply, Groundwater Supply, Flood Control, Storm Damage Prevention, Prevention of Pollution, Protection of Land Containing Shellfish, Protection of Fisheries, and Protection of Wildlife Habitat. Each wetland resource area (i.e., bank, land under water, bordering vegetated wetland, riverfront area,) as defined by the WPA regulations, is presumed to serve one or more of these interests. The regulations allow certain activities to be performed that impact these areas under its so- called " limited project" provisions (310 CMR 10.53). As noted in Section 1, regulation 10.53(4) is the regulatory mechanism whose standards are considered applicable to the proposed activities requiring a WPA permit. Section 1 of this DEIR contains excerpts from, and a discussion of, those standards at 10.53(4). They pertain to projects that " will improve the natural capacity of a resource area(s) to protect the interests identified in M.G.L. c 131, s 40." The following summarizes the resources areas, their presumed importance, and required performance standards under the WPA Regulations.

Bank

The bank is defined as the portion of land surface, which normally abuts and confines a water body. By definition, it occurs between a water body and a vegetated bordering wetland and adjacent floodplain, or, in absence of these it occurs between a water body and an upland. The upper boundary of a bank is defined as the first observable break in the slope or the mean annual flood level, which ever is lower. The lower boundary of the bank is defined as the mean annual low flow level. Banks can either by totally vegetated, or comprised of exposed soil, gravel or stone. Banks are likely to be significant to:

- public or private water supply,
- to groundwater supply, flood control,
- storm damage prevention,
- the prevention of pollution, and
- the protection of fisheries and wildlife habitat.

Where banks are constructed either of concrete, asphalt or other impervious materials, they are likely to be significant to flood control and storm damage prevention.

Work proposed on a bank shall not impair the following Performance Standards:

- Physical stability of the bank,
- Water carrying capacity of the existing channel within the bank,
- Groundwater and surface water quality,
- Capacity of the bank to provide breeding habitat, escape cover and food for fisheries,
- The capacity of the bank to provide important wildlife habitat functions.

Bordering Vegetated Wetlands

Bordering Vegetated Wetlands (BVW) is defined as areas where the soils are saturated and/or inundated such that they support a predominance of wetland indicator plants. BVW extends from the bank to a boundary line where 50 % or more of the vegetation community consists of wetland indicator plants and saturated or inundated conditions exist. As stated in the Act, BVW may be significant to:

- the protection of public or private water supply,
- protection of groundwater supply,
- flood control,

- storm damage prevention,
- prevention of pollution, and
- protection of fisheries and wildlife habitat.

Land Under Water

Land Under Water (LUW) Bodies and Waterways is defined as the land beneath a creek, river, stream, pond or lake. It may be comprised of organic muck or peak, fine sediments, rocks or bedrock. The boundaries of LUW is the mean annual low water elevation. LUW is significant to:

- public and private water supply,
- groundwater supply,
- flood control,
- storm damage prevention,
- prevention of pollution,
- protection of fisheries, and
- wildlife habitat.

When LUW is composed of an impervious material, the LUW may be significant to flood control and storm damage prevention. Any proposed work within LUW shall be in compliance with the general performance standards and not impair the following:

- The water carrying capacity within the defined channel, which is provided by said land in conjunction with the banks;
- Ground and surface water quality
- The capacity of said land to provide breeding habitat, escape cover and food for fisheries; and
- The capacity of land to provide important wildlife habitat functions.

Bordering Land Subject to Flooding

Bordering Land Subject to Flooding (BLSF) is defined as an area with low, flat topography adjacent to and inundated by flood waters rising from creeks, rivers, streams, ponds or lakes. It enters from the banks of these waterways and water bodies; where a bordering vegetated wetland occurs, it extends from the wetland. The boundary of BLSF is the estimated maximum lateral extent of flood water, which will theoretically result from the statistical 100 year frequency storm. BLSF is significant to both:

- flood control, and
- storm damage.

When a project involves the loss of flood storage, the following general performance must be met:

- Compensatory storage shall be provided for all flood storage volume that will be lost as the result of a proposed project within Bordering Land Subject to Flooding, when in the judgment of the issuing authority, said loss will cause an increase, or will contribute incrementally, to an increase in the horizontal extent and level of flood waters during peak flows.
- Compensatory storage shall mean a volume not previously used for flood storage and shall incrementally equal to the theoretical volume of flood water at each elevation, up to and including the 100-year flood elevation, which would be displaced by the proposed project. Such compensatory volume shall have an unrestricted hydraulic connection to the same waterway or water body. Further, with respect to waterways, such compensatory volume shall provide with in the same reach of the river, stream or creek.
- Work within Bordering Land Subject to Flooding, including that work required to provide the above-specified compensatory storage, shall not restrict flows so as to cause an increase in state or velocity.
- Work in those portions of bordering land subject to flooding found to be significant to the protection of wildlife habitat shall not impair its capacity to provide important wildlife habitat functions.

Riverfront Area

The riverfront area is an area of land that extends from a the mean annual high water line of perennial streams measured outward to a distance of 200 feet. However, this parallel line is located 25 feet away in towns listed in 310 CMR 10.28 (including Boston) and in densely developed areas designated by the Secretary of the Executive office of Environmental Affairs. In addition, the parallel line is located 100 feet from new agricultural and aquacultural activities.

As outlined in 310 CMR 10.58, riverfront areas may provide protection to:

- private or public water supply,
- protect groundwater,
- provide flood control,

- prevent storm damage,
- prevent pollution,
- protect land containing shellfish,
- protect wildlife habitat, and
- fisheries.

Work within the riverfront area shall meet the general performance standards as outlined in 310 CMR 10.58.

- The work shall meet the performance standards for all other resource areas within the riverfront area.
- No project, which will have any adverse effect on specified habitat sites of rare wetland or upland species, may be permitted within the riverfront area.
- There must be no practicable and substantially equivalent economic alternative to the proposed project with less adverse effects on the interests identified in the Wetland Protection Act.
- The work, including proposed mitigation measures, must have no significant adverse impact on the riverfront area to protect the interests identified in the Wetland Protection Act.

9.1.2 Section 106 of the Historic Preservation Act

Section 106 of the National Historic Preservation Act requires that before a permit/approval is issued, that every Federal agency "take into account" how a proposed project could effect historic properties. The agency and project proponent are required to work with the State Historic Preservation officer (SHPO) in this effort. In Massachusetts, the Massachusetts Historical Commission (MHC) is the SHPO and it consults with the Boston Landmarks Commission and the Brookline Preservation Commission and requests a review and comments of projects that affect Section 106 jurisdictions.

Also, the agency is required to provide an independent Federal agency known as the Advisory Council on Historic Preservation, an opportunity to comment on the project. Historic properties are those that either are listed or are eligible for listing on the National Register of Historic Places.

There are five general steps in the review process under Section 106:

- Identify and evaluate historic properties.

- Assess the effects, determining whether there will be no effect on historic properties, no adverse effect, or an adverse effect.

- Consultation.

- Council comment.

- Proceed.

The Secretary of the Interior Standards for the Treatment of Historic Properties with Guidelines for the Treatment of Cultural Landscape (SOI) are the benchmark against which the effects of a proposed project are evaluated.

In addition to its involvement under Section 106, the Boston Landmarks Commission will also be involved in the project's review as the proposed work pertains to local landmarks.

9.1.3 Water Quality Certification

A Water Quality Certification under Section 401 of the Clean Water Act (314 CMR 9.00) is required for the " discharge of dredged or fill material, dredging, and dredged material disposal activities in the waters of … the Commonwealth which require federal licenses or permits and which are subject to state water quality certification under…" Section 401 of the federal Clean Water Act. It is through this certification that the DEP ensures compliance with the Surface Water Quality Standards.

The Water Quality Certification will impose water quality standards for dredging activities and for the discharge of return water.

9.1.4 Section 404 of the Federal Clean Water Act

The Muddy River Project will require a Section 404(b)(1) permit under the Clean Water Act or otherwise be a project sponsored by the US Army Corps of Engineers. An important standard that applies under 404(b)(1) is that dredged or fill material should not be discharged into an aquatic ecosystem unless it can be demonstrated that such a discharge will not have an adverse impact on the ecosystems of concern. The ACOE asserts jurisdiction on the basis that there is a potential " discharge" associated with activity in wetlands regardless of whether there is fill or dredging involved.

The Muddy River Project includes the dredging of accumulated sediment and its disposal. Regardless of the management and mitigation techniques, the ACOE's position assumes some inherit spillage from buckets and/ or hydraulic equipment.

Section 404 requirements include:

- consideration of practicable alternatives;

- delineation of the wetland resource areas;

- evaluation of various physical and chemical parameters that characterize the non-living environment of the site;
- assessment of any special characteristics that might be affected by the proposed use of the site;
- evaluation and testing to determine the possibility of chemical contamination or physical incompatibility of the material to be discharged; and
- determination of appropriate means to minimize the environmental impacts of the discharge. Milestones include enhancing the functions and values of the resource areas (see Section 6), selecting what is known as the least environmental damaging practicable alternative (LEDPA) and monitoring.

LEDPA Evaluation

The Section 404(b)(1) Guidelines apply to aquatic and wetland ecosystems and require that any project for the discharge of dredged or fill material include the selection of the least Environmentally Damaging Practical Alternative (LEDPA). The LEDPA applies to wetland and aquatic sites, both of which will be impacted through the Muddy River Project. The Muddy River Project has been designed to be an environmental enhancement project of a large scale and includes the following objectives:

- Flood Control
- Improve Water Quality
- Enhance Aquatic and Riparian Habitat
- Restore Landscape and Historic Resources
- Institute Best Management Practices in the muddy River System

While each of these objectives results in an improvement over existing conditions, there are impacts to wetland and aquatic sites that are associated with the end result. These include:

- The discharge of small amounts of dredged material into the Muddy River even though there will be net increase of the flood channel and aquatic habit of nearly 200,000 cubic yards
- The generation of suspended solids during the dredging process,
- The removal of the invasive wetland plant, *Phragmites*,
- The disturbance of the river banks and shoreline,

The positive and mitigating aspects of the Project that out weigh the negative impacts include:

- The application of hydraulic dredging technology, wherever it can be accomplished combined with on-site sediment dewatering to minimize re-handling and transportation,
- The implementation of a Dredged Materials Management Plan, a Stormwater Pollution Prevention Plan, an Emergency Response Plan, a Spill Control, Containment and Conter measure Plan, daily monitoring and imprecations for environmental permit compliance, water quality monitoring,
- The removal of TCLP-lead hazardous sediments,
- The removal of other amounts of heavy metals and chlorinated petroleum hydrocarbons,
- The replacement of a monoculture of *Phragmites* with low habitat value with an overall increase in the ecological function and values of flood flow alteration, fish and shellfish habitat, sediment/toxicant retention, nutrient removal, product export, sediment/shoreline stabilization, wildlife habitat, and recreation.
- The repair and stabilization of eroded banks,

Therefore, the proposed Muddy River Project is the Least Environmental Damaging Practical Alternative (LEDPA).

The following sections of this part of the DEIR compare the project elements with the combined goals of the project and requirements of the primary regulatory standards. Structured according to project area, they also include a discussion of other permit standards that apply.

9.2 Charlesgate

9.2.1 Primary Regulatory Standards

Table 9-1 lists the project elements in the Charlesgate area and compares them to the regulatory issues outlined above.

Removing obstructions from the waterway in Charlesgate will result in partial flood control benefits, but will not contribute to the other objectives of the project, namely water quality improvement, aquatic, wetland, and wildlife habitat enhancement or historic bank restoration. This activity also will prevent some level of flood damage, but will not serve additional WPA interests. The work at Charlesgate is not expected to improve the natural capacity of resource areas (i.e., bank, bvw, luw, or riverfront area) as they either don't exist or, as in the case of LUW, are man-made). Previous disturbance at Charlesgate relating to the Bowker Overpass, destroyed many features from the Primary and Secondary Periods of Significance. However, grading,

	Project Objectives								WPA Interests (C. 131, Sec. 40)								10.53(4) WPA Regs					Section 106			401 W.Q.C. 9.04		C.W.A. 404(b)(1)		
Charlesgate Project Elements	Provide Flood Control	Water Quality Improvement	Enhance Aquatic/Riparian Habitat	Enhancement of Aquatic Habitat	Enhancement of Wetland Habitat	Enhancement of Wildlife Habitat	Restore Landscaping & Historic Resources	Implement Best Management Practices	Public/Private Water Supply	Groundwater Supply	Flood Control	Storm Damage Prevention	Prevention of Pollution	Protection of Land Containing Shellfish	Protection of Fisheries	Protection of Wildlife Habitat	Improve Natural Capacity of Bank	Improve Natural Capacity of BVW	Improve Natural Capacity of LUW	Improve Natural Capacity of Riverfront Area	No Adverse Impact to Rare Species Habitat	No Effect on Historic Resources	No Adverse Effect on Historic Resources	Adverse Effect on Historic Resources	Meets Water Quality Standards	Rare/Endangered Species Habitat	Enhanced Functions and Values	LEDPA	Monitoring
Remove waterway obstructions	⬩	O	O	O	O	O	O	O	n/a	n/a	⬩	⬩	O	n/a	O	O	n/a	n/a	n/a	n/a	n/a	n/a	◆	O	⬩	n/a	O	O	O
Dredge approximately 3,300 cubic yards (cy) of sediment and debris	◆	◆	⬩	◆	O	O	O	⬩	n/a	n/a	◆	◆	O	n/a	◆	O	n/a	n/a	n/a	n/a	n/a	n/a	◆	O	◆	n/a	O	⬩	O
Plant new vegetation	O	O	⬩	O	O	⬩	O	⬩	n/a	n/a	O	O	O	n/a	O	⬩	n/a	n/a	n/a	⬩	n/a	n/a	◆	O	⬩	n/a	⬩	⬩	O
Repair and replace worn pathways	O	O	⬩	O	O	O	O	⬩	n/a	n/a	O	O	O	n/a	O	O	n/a	n/a	n/a	O	n/a	n/a	◆	O	⬩	n/a	O	O	O
Install new park benches	O	O	⬩	O	O	O	O	O	n/a	n/a	O	O	O	n/a	O	O	n/a	n/a	n/a	O	n/a	n/a	◆	O	O	n/a	O	O	O
Implement Best Management Practices	O	◆	⬩	⬩	O	O	O	◆	n/a	n/a	O	O	◆	n/a	◆	O	n/a	n/a	n/a	O	n/a	n/a	◆	O	◆	n/a	O	O	◆
Combined effect of all the proposed project elements	◆	◆	◆	◆	O	⬩	O	◆	n/a	n/a	◆	◆	◆	n/a	◆	⬩	n/a	n/a	n/a	⬩	n/a	n/a	◆	O	◆	n/a	⬩	◆	◆

Legend

◆	Meets the project objectives and regulatory interests/standards
⬩	Partially meets the project objectives and regulatory interests/standards
O	Does not meet the project objectives and regulatory interests/standards
n/a	Not applicable

Table 9-1

Charlesgate Area: Comparison of Project Elements Project Objectives/Regulatory Interest/Standards

Source Cortell Assoc.

vegetation, trees, surrounding structures and spatial relationships within the Charlesgate area contribute to its historic character. The Charlesgate East Gatehouse and a small structure along the Muddy River and adjacent to the end of Ipswich Street are the only character defining features from the Primary Period (Olmsted) and the remaining balustrade areas are the only features that are extant from the Secondary Period (Shurtleff). These historic features will be protected during construction so the impact on the character of the parkland will be minimal. The 404(b)(1) functions and values and related criteria are not applicable.

Dredging sediment and debris removal from the Charlesgate will benefit flood control, water quality, aquatic habitat, storm damage prevention and fisheries. Other listed goals or standards either don't apply or will not benefit from this particular activity.

Planting new vegetation will have partial benefit to wildlife habitat at Charlesgate and similar benefit to natural capacity of the Riverfront area.

Repairing and replacing worn pathways, and installing new park benches at Charlesgate will improve the recreational use of the area, although this benefit is not a listed goal or regulatory interest.

Implementing Best Management Practices (BMP's) in the Charlesgate Area will result in water quality improvements, and will result in some degree of aquatic habitat improvement. As one would anticipate, it will serve the interest of prevention of pollution and protection of fisheries. Monitoring will be accomplished to determine the effectiveness of BMP's over time.

The combined effect of the project elements at Charlesgate will entail meeting the majority of the project objectives, the WPA interests, and the 404(b)(1) standards. Improvements to the capacity of WPA resources are limited by the extent that those resources exist at Charlesgate. Historic preservation standards of "no effect" and "no adverse effect" will be met.

9.2.2 Charlesgate Permits/Approvals

9.2.2.1 Notice of Intent/Order of Conditions

In Massachusetts, local conservation commissions and the Department of Environmental Protection (DEP) share responsibility for enforcing the provisions of Wetlands Protection Act (WPA). The process begins with a local filing (a Notice of Intent).

An approval (Order of Conditions) first is sought locally, but an appeal of the local approval to or by the DEP can result in a state approval (Superceding Order of Conditions) that will supercede the local approval. A related process, which is dovetailed with the local permit applications, is approval under the City of Boston local Wetland by-law. A Notice of Intent will be submitted to the Boston Conservation Commission prior to initiating any work within the jurisdiction of this local entity under either the WPA or the City of Boston's by-law. Boston's wetland by-law will not add substantively to the required N.O.I. Rather, it will impose an additional filing fee to that required under the WPA.

Construction activities within the Charlesgate area will involve temporary disturbance of limited resource areas under the WPA, namely, Land Under Water. In addition, staging area activities will be located within the 100-foot buffer zone.

Buffer zone activities must be accomplished such that they do not impact the resource areas.

9.2.2.2 Water Quality Certification

According to 314 CMR 9.00, "401" Water Quality Certification is required for the " discharge of dredged or fill material, dredging, and dredged material disposal activities in the waters of … the Commonwealth which require federal licenses or permits and which are subject to state water quality certification under…" Section 401 of the federal Clean Water Act. It is through this certification that the DEP ensures compliance with the Surface Water Quality Standards.

Water Quality Certification will impose water quality standards for dredging activities and for the discharge of return water. Proposed water quality standards are discussed in Section 6.

9.2.2.3 Chapter 91 Waterways Permitting

According to 310 CMR 9.00, permitting from the DEP, Division of Waterways will be required for the dredging proposed in the Muddy River, including Charlesgate, which is currently a -

> *" … non-tidal river or stream on which public funds have been expended for stream clearance, channel improvement, or any form of flood control or prevention work, either upstream or downstream within the river basin, except for any such river or stream which is not normally navigable during any season, by any vessel including canoe, kayak, raft, or rowboat;…"*

Regulation 9.40 sets forth requirements for dredging and dredge disposal activities that must be met by the project. They include provisions to 1) set limits for the depth of dredging; 2) schedule the dredging and disposal activities so as to avoid interference with anadromous and catadromous fish runs; 3) impose operational requirements for dredging and dredge material disposal; and 4) supervise the dredging and dredge disposal activities.

A Dredge Material Management Plan (DMMP) for the project, including Charlesgate will be developed in accordance with parameters outlined in Section 7 to ensure that the Contractor conducting the work will meet Chapter 91 standards.

9.2.2.4 Clean Water Act Compliance

The Charlesgate portion of the project will require a Section 404(b)(1) permit under the Clean Water Act. An important standard that applies under 404(b)(1) is that dredged or fill material should not be discharged into an aquatic ecosystem unless it can be demonstrated that such a discharge will not have an adverse impact on the ecosystems of concern. Requirements include:

- consideration of practicable alternatives;
- delineation of the wetland resource areas;
- evaluation of various physical and chemical parameters that characterize the non-living environment of the site;
- assessment of any special characteristics that might be affected by the proposed use of the site;
- evaluation and testing to determine the possibility of chemical contamination or physical incompatibility of the material to be discharged; and
- determination of appropriate means to minimize the environmental impacts of the discharge.

Alternatives to the work proposed at Charlesgate are discussed in Section 2. Wetland resources were delineated and accepted by the Boston Conservation Commission (Appendix L). Existing conditions, including a description of the non-living environment are described in Section 4. An analysis of impacts is contained in Section 6 which also summarizes the sediment and water quality testing that was conducted and which is reported on extensively in Appendices F and G. Environmental mitigation is described in Section 7.

9.2.2.5 Section 106 of the Federal Historic Preservation Act

Charlesgate is part of the Back Bay Fens which in turn, is a section of the Olmsted Park System, and listed on the National Register. It is adjacent to The Fenway-Boylston Street Historic District, which also is listed.

The improvements proposed at Charlesgate are anticipated to have a beneficial effect (not merely "no adverse effect") on historical importance of the Back Bay Fens and abutting Fenway- Boylston Street District. In that the proposed dredging and limited park improvements at Charlesgate will restore partially, elements of the area to its "Olmsted" status. As described in detail in Section 4, this part of the project area was altered significantly when the Bowker Overpass was constructed. While the dominating presence of the overpass will remain, the landscaping and lighting features that are proposes will result in an improvement as compared to existing conditions.

9.2.2.6 MEPA Annual Update

Though not strictly a regulatory or statutory requirement, a proposed outline for the Annual Update (AU) was required by the Secretary under the Special Review Procedures (see Section 9.3.6.7) Its purpose generally is to provide continuity and flexibility in the reporting on progress of the Muddy River Project. Based on the proposed schedule for advancing the Charlesgate portion of the Muddy River Project, it is assumed that the first AU filed, will provide an update on the progress of implementation of Charlesgate improvements and on the mitigation effectiveness at that location. Section 9.3.7.6 and Table 9-7 provide more detail regarding the proposed format for the Annual Update.

9.3 Balance of the Proposed Phase 1 Work- Back Bay Fens, The Riverway, Leverett Pond, Willow Pond, and Wards Pond

9.3.1 Back Bay Fens

Table 9-2 summarizes the project elements at the Back Bay Fens and compares them with the project objectives and primary regulatory interests and standards.

Dredging to remove sediment and debris from the flood channel meets the either partially or completely, the goals of flood control, water quality improvement, aquatic habitat enhancement, storm damage prevention, prevention of pollution, protection of fisheries, and enhanced functions and values.

Dredging for Phragmites removal and restoring the natural bank at the Back Bay Fens will meet, at least partially, all of the project goals, including that to restore the historic bank.

Daylighting culverted sections of the Muddy River at the Fens Bridge and former Sears parking lot will partially meet all project objectives with the exception of water quality improvement. Although its primary objective is flood control, it will partially meet the applicable WPA interests; will improve the capacity of all state identified resources areas; and will improve the functions and values under 404(b)(1) as compared to existing conditions.

Replacing culverts at The Riverway, Brookline Avenue and repairing the Fens Bridge culvert will meet the flood control objective and partially meets the restoration of historic resources. All applicable WPA interests will be met with no adverse long-term impact of the identified resources.

Preserving historic park features through revegetaion of the new bank with wetland, shoreline and upland plants will meet all project objectives with the exception of flood control; all applicable WPA interests; and will improve the natural capacity of all state identified resource areas with no adverse impact to rare species habitat. The 404(b)(1) milestones will be met, at least partially, by this proposed action which

	Project Objectives								WPA Interests (C. 131, Sec. 40)								10.53(4) WPA Regs					Section 106			401 W.Q.C. 9.04		C.W.A. 404(b)(1)		
Back Bay Fens Project Elements	Provide Flood Control	Water Quality Improvement	Enhance Aquatic/Riparian Habitat	Enhancement of Aquatic Habitat	Enhancement of Wetland Habitat	Enhancement of Wildlife Habitat	Restore Landscaping & Historic Resources	Implement Best Management Practices	Public/Private Water Supply	Groundwater Supply	Flood Control	Storm Damage Prevention	Prevention of Pollution	Protection of Land Containing Shellfish	Protection of Fisheries	Protection of Wildlife Habitat	Improve Natural Capacity of Bank	Improve Natural Capacity of BVW	Improve Natural Capacity of LUW	Improve Natural Capacity of Riverfront Area	No Adverse Impact to Rare Species Habitat	No Effect on Historic Resources	No Adverse Effect on Historic Resources	Adverse Effect on Historic Resources	Meets Water Quality Standards	Rare/Endangered Species Habitat	Enhanced Functions and Values	LEDPA	Monitoring
Improve flood carrying capacity by dredging approximately 95,450 cubic yards (cy) of sediment and debris for a flood channel	◆	♦	♦	♦	○	○	○	♦	n/a	n/a	◆	◆	♦	n/a	♦	○	○	○	♦	○	○	n/a	◆	○	◆	n/a	♦	○	○
Dredge a flood channel and remove approximately 23,500 cy of Phragmites and restore the natural bank	◆	♦	♦	♦	♦	♦	♦	♦	n/a	n/a	◆	◆	♦	n/a	◆	♦	♦	○	♦	○	n/a	n/a	◆	○	◆	n/a	♦	○	○
Daylight presently culverted sections at the Fens Bridge and the former Sears parking lot	◆	○	♦	♦	♦	♦	♦	♦	n/a	n/a	◆	♦	○	n/a	♦	♦	♦	♦	♦	♦	n/a	n/a	◆	○	◆	n/a	♦	○	○
Construct culverts at Riverway, Brookline Avenue and new headwalls at Fens Bridge	◆	○	♦	♦	♦	○	♦	♦	n/a	n/a	◆	◆	○	n/a	○	○	♦	○	♦	♦	n/a	n/a	◆	○	♦	n/a	♦	○	○
Preserve historic park features by constructing new culverts with historically treated headwalls, revegetating the new bank with wetland, shoreline and upland plants	○	♦	♦	♦	◆	◆	◆	♦	n/a	n/a	○	♦	♦	n/a	♦	◆	◆	◆	◆	◆	n/a	n/a	◆	○	◆	n/a	◆	♦	◆
Repair or replace worn pathways and denuded ground	○	♦	♦	○	○	○	○	♦	n/a	n/a	○	♦	♦	n/a	○	○	○	○	○	♦	n/a	n/a	◆	○	♦	n/a	○	○	○
Implement Best Management Practices	○	◆	♦	◆	○	○	○	◆	n/a	n/a	○	○	◆	n/a	◆	○	♦	♦	◆	♦	♦	n/a	◆	○	◆	n/a	◆	◆	◆
Combined effect of all the proposed project elements	◆	♦	◆	◆	◆	◆	◆	◆	n/a	n/a	◆	◆	♦	n/a	◆	◆	◆	◆	◆	◆	n/a	n/a	◆	○	◆	n/a	◆	◆	◆

Legend

◆	Meets the project objectives and regulatory interests/standards
♦	Partially meets the project objectives and regulatory interests/standards
○	Does not meet the project objectives and regulatory interests/standards
n/a	Not applicable

Table 9-2

Back Bay Fens: Comparison of Project Elements Project Objectives/Regulatory Interest/Standards

Source Cortell Assoc

simultaneously will have a positive effect on historic resources. Historic benefits include historic restoration upstream of the Fens Bridge and rehabilitation of the historic shoreline at the former Sears parking lot. Head walls will be designed to include historic treatment. All restoration will be in accordance with the Emerald Necklace Master Plan.

The preservation of historic structures also includes the maintenance of bridges and the protection of the masonry from the effects of vegetation growing in the mortises.

In February, 2001, the BPRD filed a Notice of Project Change for the cutting and removal of vegetation from the Agassiz Bridge and surrounding upland area. This maintenance and planting will start in 2002 and it is outside of the revegetation plans that are contained in Appendix I - Preliminary Design Report. The replanting at the bridge included plant materials from the 1988 planting plan. The MEPA Certificate indicated that no further MEPA review is required. The BPRD is consulting with the Boston Conservation Commission on the proposed plant removal and revegetation.

Repairing or replacing worn pathways in the Back Bay Fens will meet the project goal of water quality improvement, albeit minimally, and related interests and standards of storm damage prevention, prevention of pollution, and improvement of the riverfront area capacity.

Implementing BMP's at the Back Bay Fens, as elsewhere in the remainder of Muddy River project will meet multiple project objectives, will improve the natural capacity of the wetland resource areas, and will meet all standards under 404(b)(1).

The combined effect of all project elements proposed at the Back Bay Fens meets all applicable goals and standards.

9.3.2 The Riverway

Table 9-3 compares the project elements at The Riverway with the project objectives and primary regulatory interests and standards.

Dredging to remove sediment, debris, and Phragmites to improve flood carrying capacity at The Riverway will meet project objectives for flood control, water quality, aquatic habitat, and historic bank restoration and will serve related WPA interests of flood control, storm damage prevention, and prevention of pollution. All Section 404(b)(1) standards will be met by this activity. The long-term effect on historic resources will be positive.

Repairing and replacing worn pathways and denuded ground at The Riverway will partially meet the objective of water quality improvement. It will serve the WPA interest of preventing pollution and will improve the natural capacity of riverfront resource area. The long-term effect on historic resources will be positive.

	Project Objectives								WPA Interests (C. 131, Sec. 40)								10.53(4) WPA Regs					Section 106			401 W.Q.C. 9.04		C.W.A. 404(b)(1)		
Riverway Project Elements	Provide Flood Control	Water Quality Improvement	Enhance Aquatic/Riparian Habitat	Enhancement of Aquatic Habitat	Enhancement of Wetland Habitat	Enhancement of Wildlife Habitat	Restore Landscaping & Historic Resources	Implement Best Management Practices	Public/Private Water Supply	Groundwater Supply	Flood Control	Storm Damage Prevention	Prevention of Pollution	Protection of Land Containing Shellfish	Protection of Fisheries	Protection of Wildlife Habitat	Improve Natural Capacity of Bank	Improve Natural Capacity of BVW	Improve Natural Capacity of LUW	Improve Natural Capacity of Riverfront Area	No Adverse Impact to Rare Species Habitat	No Effect on Historic Resources	No Adverse Effect on Historic Resources	Adverse Effect on Historic Resources	Meets Water Quality Standards	Rare/Endangered Species Habitat	Enhanced Functions and Values	LEDPA	Monitoring
Improve flood carrying capacity by dredging approximately 21,000 cy of sediment and debris and 9,000 cy of Phragmites for a flood channel	◆	⬩	⬩	⬩	O	O	◆	⬩	n/a	n/a	◆	◆	⬩	n/a	⬩	O	O	O	O	O	n/a	n/a	◆	O	◆	n/a	O	O	O
Dredge a flood channel and revegetate the new bank by establishing wetland, shoreline and upland plants	◆	⬩	⬩	◆	◆	◆	◆	⬩	n/a	n/a	◆	◆	⬩	n/a	◆	◆	◆	◆	◆	◆	n/a	n/a	◆	O	◆	n/a	◆	◆	◆
Repair or replace worn pathways and denuded ground	O	⬩	⬩	O	O	O	O	⬩	n/a	n/a	O	O	⬩	n/a	O	O	O	O	O	⬩	n/a	n/a	◆	O	⬩	n/a	⬩	O	O
Implement Best Management Practices	O	◆	⬩	◆	O	O	O	◆	n/a	n/a	O	O	◆	n/a	◆	O	O	O	◆	O	n/a	n/a	◆	O	◆	n/a	◆	◆	◆
Combined effect of all the proposed project elements	◆	⬩	◆	◆	◆	◆	◆	◆	n/a	n/a	◆	◆	⬩	n/a	◆	◆	◆	◆	◆	◆	n/a	n/a	◆	O	◆	n/a	◆	◆	◆

Legend

◆	Meets the project objectives and regulatory interests/standards
⬩	Partially meets the project objectives and regulatory interests/standards
O	Does not meet the project objectives and regulatory interests/standards
n/a	Not applicable

Table 9-3
Riverway: Comparison of Project Elements
Project Objectives/Regulatory Interest/Standards

Source Cortell Assoc

Implementing BMP's at The Riverway will meet project objectives of water quality improvement and aquatic habitat enhancement and related WPA interests of prevention of pollution and protection of fisheries. Proposed BMP's will improve the natural capacity of land under water. Section 404(b)(1) standards also will be met. The long-term effect on historic resources will be positive.

Proceeding on an independent schedule from either the Charlesgate or the balance of the Phase I work, is the separation of surface runoff from the Back Bay Yard into the local sanitary sewer. This BMP was noticed in the Environmental Monitor on August 22, 2001. It included the construction of 300 linear feet of storm drain, 2 standard hooded catch basins, a deep sump catch basin with a deeper hood, an infiltration chamber and an overflow from the chamber for high storm flows. The MEPA Certificate on the Notice of Project Change indicated that no further MEPA review was necessary. The BPRD has submitted the plans to the Boston Conservation Commission and has received its order of conditions.

The combined effect of all project elements at The Riverway will meet all applicable goals and standards.

9.3.2 Leverett Pond

Table 9-4 compares the project elements at Leverett Pond with the project objectives and primary regulatory interests and standards.

Dredging to improve the flood capacity at Leverett Pond will partially meet the project objectives of flood control, water quality improvement and aquatic habitat enhancement and related WPA interests of flood control, storm damage prevention and protection of fisheries. It also will improve the natural capacity of Land Under Water.

Preserving the historic shoreline through the reorientation of Daisy Field will partially meet project objectives of water quality improvement, and aquatic and wildlife habitat enhancement. It will contribute towards the interest of preventing pollution and will result in an improvement of the natural capacity of the bank, land under water, and the riverfront area. The long-term effect on historic resources will be positive.

Preserving historic features through the revegetation of new bank, an island and the establishment of wetland, shoreline and upland plantings will meet all project objectives except flood control. The WPA interests served by this activity include prevention of pollution, protection of fisheries, and the protection of wildlife habitat. The natural capacity of the bank, of bordering vegetated wetland, and of the riverfront area, all will be improved by this work. It will result in enhanced functions and values (see Section 6) and will meet other standards under Section 404(b)(1) regarding alternatives and monitoring. The long-term effect on historic resources will be positive.

	Project Objectives								WPA Interests (C. 131, Sec. 40)								10.53(4) WPA Regs					Section 106			401 W.Q.C. 9.04		C.W.A. 404(b)(1)		
Leverett Pond Project Elements	Provide Flood Control	Water Quality Improvement	Enhance Aquatic/Riparian Habitat	Enhancement of Aquatic Habitat	Enhancement of Wetland Habitat	Enhancement of Wildlife Habitat	Restore Landscaping & Historic Resources	Implement Best Management Practices	Public/Private Water Supply	Groundwater Supply	Flood Control	Storm Damage Prevention	Prevention of Pollution	Protection of Land Containing Shellfish	Protection of Fisheries	Protection of Wildlife Habitat	Improve Natural Capacity of Bank	Improve Natural Capacity of BVW	Improve Natural Capacity of LUW	Improve Natural Capacity of Riverfront Area	No Adverse Impact to Rare Species Habitat	No Effect on Historic Resources	No Adverse Effect on Historic Resources	Adverse Effect on Historic Resources	Meets Water Quality Standards	Rare/Endangered Species Habitat	Enhanced Functions and Values	LEDPA	Monitoring
Improve flood carrying capacity by dredging approximately 23,000 cubic yards (cy) of sediment	⬩	⬩	⬩	⬩	O	O	O	⬩	n/a	n/a	⬩	⬩	O	n/a	⬩	O	O	O	◆	O	n/a	n/a	◆	O	◆	n/a	O	O	O
Preserve the historic shoreline through the reorientation of the Daisy Field backstop/playing filed	O	⬩	⬩	⬩	⬩	O	⬩	O	n/a	n/a	O	O	⬩	n/a	O	O	⬩	O	⬩	⬩	n/a	n/a	◆	O	⬩	n/a	O	O	O
Preserve historic park features through the revegetation of the new bank, an island and the establishment of wetland, shoreline and upland plants	O	⬩	⬩	⬩	◆	◆	◆	⬩	n/a	n/a	O	O	⬩	n/a	⬩	⬩	◆	◆	O	⬩	n/a	n/a	◆	O	◆	n/a	◆	◆	◆
Restore the "babbling brook" at the inlet to Leverett Pond from Willow Pond	O	O	⬩	⬩	O	O	⬩	⬩	n/a	n/a	O	O	O	n/a	⬩	O	O	O	⬩	⬩	n/a	n/a	◆	O	◆	n/a	⬩	O	O
Repair or replace worn pathways and denuded ground	O	⬩	⬩	O	O	O	O	⬩	n/a	n/a	O	O	⬩	n/a	O	O	O	O	O	⬩	n/a	n/a	◆	O	⬩	n/a	O	O	O
Implement Best Management Practices	O	◆	⬩	◆	O	O	O	◆	n/a	n/a	O	O	◆	n/a	⬩	O	O	O	◆	O	n/a	n/a	◆	O	◆	n/a	◆	◆	◆
Combined effect of all the proposed project elements	⬩	◆	◆	◆	◆	◆	◆	◆	n/a	n/a	⬩	⬩	◆	n/a	⬩	O	◆	◆	◆	◆	n/a	n/a	◆	O	◆	n/a	◆	◆	◆

Legend

◆	Meets the project objectives and regulatory interests/standards
⬩	Partially meets the project objectives and regulatory interests/standards
O	Does not meet the project objectives and regulatory interests/standards
n/a	Not applicable

Table 9-4
Leverett Pond: Comparison of Project Elements
Project Objectives/Regulatory Interest/Standards

Source Cortell Assoc

Restoring the Babbling Brook at the inlet to Leverett Pond from Willow Pond will partially meet project objectives of enhancing aquatic habitat and historic bank restoration and will serve the related WPA interest of protection of fisheries. It also will improve the natural capacity of land under water and riverfront area and will improve functions and values as compared to existing conditions. The long-term effect on historic resources will be positive.

Repairing or replacing worn pathways in Leverett Pond will meet the project goal of water quality improvement, albeit minimally, and related interests and standards of storm damage prevention, prevention of pollution, and improvement of the riverfront area capacity.

Implementing BMP's at Leverett Pond will meet project objectives of improving water quality and enhancing aquatic habitat. Related WPA interests that will be served byLeverett Pond BMP's include prevention of pollution and protection of fisheries. Land under water is the resource area that will experience improvements in natural capacity. Section 404(b)(1) standards for functions and values, alternatives, and monitoring will be met by the proposed BMP's. The long-term effect on historic resources will be positive.

The combined effect of all project elements at Leverett Pond will meet all project objectives, most applicable WPA interests, and will improve the natural capacity of all wetland resource areas present.

9.3.4 Willow Pond

Table 9-5 compares the project elements at Willow Pond with the project objectives and primary regulatory interests and standards.

Dredging sediment to improve flood storage capacity will meet project objectives for flood control, water quality improvement, and enhancement of aquatic habitat and related WPA interests of flood control, storm damage prevention, prevention of pollution, and protection of fisheries. It will have the notable benefit of enhancing rare species (three spine stickleback). The long-term effect on historic resources will be positive.

Dredging to preserve historic park features will meet or partially meet all applicable project objectives except flood control. It will meet or partially meet all other applicable interests and standards.

Enhancing the three spine stickleback habitat will improve the aquatic and wetland habitat, will protect fisheries, and will improve the natural capacity of land under water, riverfront area, and rare species habitat. The long-term effect on historic resources will be positive.

Repairing the rock dam between Spring Pond and Willow Pond will meet all project objectives (including historic bank restoration) except flood control and water quality improvement. Natural capacity of all affected wetland resource areas will be

	Project Objectives								WPA Interests (C. 131, Sec. 40)								10.53(4) WPA Regs					Section 106			401 W.Q.C. 9.04		C.W.A. 404(b)(1)		
Willow Pond Project Elements	Provide Flood Control	Water Quality Improvement	Enhance Aquatic/Riparian Habitat	Enhancement of Aquatic Habitat	Enhancement of Wetland Habitat	Enhancement of Wildlife Habitat	Restore Landscaping & Historic Resources	Implement Best Management Practices	Public/Private Water Supply	Groundwater Supply	Flood Control	Storm Damage Prevention	Prevention of Pollution	Protection of Land Containing Shellfish	Protection of Fisheries	Protection of Wildlife Habitat	Improve Natural Capacity of Bank	Improve Natural Capacity of BVW	Improve Natural Capacity of LUW	Improve Natural Capacity of Riverfront Area	No Adverse Impact to Rare Species Habitat	No Effect on Historic Resources	No Adverse Effect on Historic Resources	Adverse Effect on Historic Resources	Meets Water Quality Standards	Rare/Endangered Species Habitat	Enhanced Functions and Values	LEDPA	Monitoring
Dredge approximately 6,000 cubic yards (cy) of sediment	O	⬩	⬩	⬩	O	O	O	⬩	n/a	n/a	◆	◆	⬩	n/a	⬩	O	O	O	O	O	◆	n/a	◆	O	◆	⬩	O	O	O
Preserve historic park features by revegetation of the new bank, the reintroduction of an island and the establishment of wetland, shoreline and upland plants	⬩	⬩	⬩	◆	◆	◆	◆	⬩	n/a	n/a	◆	◆	⬩	n/a	⬩	◆	◆	◆	◆	◆	n/a	n/a	◆	O	◆	⬩	◆	◆	◆
Enhance the habitat of the three-spine stickleback	O	O	⬩	⬩	⬩	O	O	⬩	n/a	n/a	O	O	O	n/a	◆	O	O	O	⬩	⬩	n/a	n/a	◆	O	⬩	◆	◆	◆	◆
Repair the rock dam between Spring Pond and Willow Pond	O	O	⬩	⬩	⬩	⬩	⬩	O	n/a	n/a	O	O	O	n/a	⬩	⬩	⬩	⬩	⬩	⬩	◆	n/a	◆	O	⬩	◆	⬩	⬩	O
Repair or replace worn pathways and denuded ground	O	⬩	⬩	O	O	O	O	◆	n/a	n/a	O	O	⬩	O	O	O	O	O	O	⬩	n/a	n/a	◆	O	⬩	⬩	O	O	O
Implement Best Management Practices	O	◆	⬩	◆	O	O	O	◆	n/a	n/a	O	O	◆	n/a	◆	O	O	O	◆	O	n/a	n/a	◆	O	◆	◆	◆	◆	◆
Combined effect of all the proposed project elements	⬩	◆	◆	◆	◆	◆	◆	◆	n/a	n/a	◆	◆	◆	n/a	◆	◆	◆	◆	◆	◆	n/a	n/a	◆	O	◆	◆	◆	◆	◆

Legend

◆	Meets the project objectives and regulatory interests/standards
⬩	Partially meets the project objectives and regulatory interests/standards
O	Does not meet the project objectives and regulatory interests/standards
n/a	Not applicable

Table 9-5
Willow Pond: Comparison of Project Elements
Project Objectives/Regulatory Interest/Standards

Source. Cortell Assoc

improved by this task, and the rare species habitat will be improved. The long-term effect on historic resources will be positive.

Repairing or replacing worn pathways will meet project objectives, interests and standards, much the same as identified in areas of the project downstream and upstream of Willow Pond, as will implementing BMP's at Willow Pond.

The combined effect of all project elements at Willow Pond will meet virtually all project objectives and regulatory interests and standards.

Dredging sediment to improve flood storage capacity will meet project objectives for flood control, water quality improvement, and enhancement of aquatic habitat and related WPA interests of flood control, storm damage prevention, prevention of pollution, and protection of fisheries. It will have the notable benefit of enhancing rare species (three spine stickleback). The long-term effect on historic resources will be positive. Historic restoration will be in accordance with the Emerald Necklace Master Plan.

9.3.5 Wards Pond

Table 9-6 compares the project elements at Willow Pond with the project objectives and primary regulatory interests and standards.

Dredging to improve the flood capacity will meet project objectives of improving water quality and enhancing aquatic habitat. It will serve the interest of protecting fisheries and will improve the natural capacity of land under water. The long-term effect on historic resources will, like Willow Pond, be positive.

Restoring the historic park shoreline through the restoration of turf beaches will meet the project goal of historic bank restoration and will improve the natural capacity of land under water. The long-term effect on historic resources will be positive. Restoration will be in accordance with the Emerald Necklace Master Plan

Preserving historic park features by establishing wetland, shoreline, and upland plant species along the brook outlet will meet all project goals except those of flood control and water quality improvement. The WPA interest of protecting wildlife habitat will be met by this project element which also will improve the natural capacity of bank, bordering vegetated wetland, and riverfront area at Wards Pond. The long-term effect on historic resources will be positive

Repair or replace worn pathways and denuded ground and implementing BMP's will meet similar objectives and standards as elsewhere in the Muddy river Project.

The combined effect of all project elements proposed at Wards Pond will be to meet almost of the project objectives and to improve the natural capacity of all listed WPA resource areas.

	Project Objectives								WPA Interests (C. 131, Sec. 40)								10.53(4) WPA Regs					Section 106			401 W.Q.C. 9.04		C.W.A. 404(b)(1)		
Wards Pond Project Elements	Provide Flood Control	Water Quality Improvement	Enhance Aquatic/Riparian Habitat	Enhancement of Aquatic Habitat	Enhancement of Wetland Habitat	Enhancement of Wildlife Habitat	Restore Landscaping & Historic Resources	Implement Best Management Practices	Public/Private Water Supply	Groundwater Supply	Flood Control	Storm Damage Prevention	Prevention of Pollution	Protection of Land Containing Shellfish	Protection of Fisheries	Protection of Wildlife Habitat	Improve Natural Capacity of Bank	Improve Natural Capacity of BVW	Improve Natural Capacity of LUW	Improve Natural Capacity of Riverfront Area	No Adverse Impact to Rare Species Habitat	No Effect on Historic Resources	No Adverse Effect on Historic Resources	Adverse Effect on Historic Resources	Meets Water Quality Standards	Rare/Endangered Species Habitat	Enhanced Functions and Values	LEDPA	Monitoring
Dredge approximately 15,600 cubic yards (cy) of sediment	O	♦	♦	◆	O	O	O	♦	n/a	n/a	O	O	O	n/a	◆	O	O	O	♦	O	n/a	n/a	◆	O	◆	n/a	♦	O	O
Preserve the historic park shoreline through the restoration of the turf beaches	O	O	◆	O	O	O	♦	O	n/a	n/a	O	O	O	n/a	◆	◆	◆	◆	◆	O	n/a	n/a	◆	O	♦	n/a	O	O	O
Preserve historic park features by the establishment of wetland, shoreline and upland species along the outlet from the pond	O	O	♦	♦	♦	♦	♦	♦	n/a	n/a	O	O	O	n/a	♦	♦	♦	♦	O	♦	n/a	n/a	◆	O	♦	n/a	♦	O	O
Repair or replace worn pathways and denuded ground	O	♦	♦	♦	O	O	♦	♦	n/a	n/a	O	O	♦	n/a	O	O	♦	O	O	♦	n/a	n/a	◆	O	♦	n/a	♦	O	O
Implement Best Management Practices	O	♦	♦	♦	O	O	O	◆	n/a	n/a	O	O	♦	n/a	♦	O	n/a	n/	♦	O	n/a	n/a	◆	O	♦	n/a	♦	♦	♦
Combined effect of all the proposed project elements	O	♦	◆	◆	♦	♦	♦	◆	n/a	n/a	O	O	♦	n/a	◆	◆	◆	◆	◆	♦	n/a	n/a	◆	O	◆	n/a	♦	♦	♦

Legend

◆	Meets the project objectives and regulatory interests/standards
♦	Partially meets the project objectives and regulatory interests/standards
O	Does not meet the project objectives and regulatory interests/standards
n/a	Not applicable

Table 9-6
Wards Pond: Comparison of Project Elements
Project Objectives/Regulatory Interest/Standards

Source Cortell Assoc

9.3.6 Permits/ Approvals – Remainder of the Project Area

9.3.6.1 Notice of Intent/Order of Conditions

Notices of Intent (NOI) will be filed with the Boston and Brookline Conservation Commissions from whom Orders of Conditions under the Massachusetts Wetland Protection Act Regulations (310 CMR 10.00) must be sought for work within and adjacent to the Muddy River and its wetland resources. The first step towards this goal has been taken. During the preparation of this DEIR, the proponent sought and was granted acceptance of the delineation of wetland resources from both commissions through the filing of what is known as Abbreviated Notices of Resource Area Delineation (ANRAD). See Appendix L for evidence that the Boston and Brookline Conservation Commissions accepted the resource area delineations.

NOI filings will occur after the Draft and Final EIRs are reviewed. In addition to addressing the state WPA requirements, the NOI also will address issues that may be required under local by-laws in Brookline, and will meet any additional filing fee requirements associated with these by-laws.

9.3.6.2 Water Quality Certification

According to 314 CMR 9.00, "401" Water Quality Certification is required for the "discharge of dredged or fill material, dredging, and dredged material disposal activities in the waters of … the Commonwealth which require federal licenses or permits and which are subject to state water quality certification under"… Section 401 of the federal Clean Water Act. It is through this certification that the DEP ensures compliance with the Surface Water Quality Standards.

Water Quality Certification will impose water quality standards for dredging activities and for the discharge of return water. Proposed water quality standards for these activities are provided in Section 6.

9.3.6.3 Chapter 91 Waterways Permitting

As with the Charlesgate portion of the project, a Chapter 91 Waterways permit must be obtained before dredging of the remainder of the site can occur. 310 CMR 9.40 sets forth requirements for dredging and dredge disposal activities that must be met by the project. They include provisions to 1) set limits for the depth of dredging; 2) schedule the dredging and disposal activities so as to avoid interference with anadromous an catadromous fish runs; 3) impose operational requirements for dredging and dredge material disposal; and 4) supervise the dredging and dredge disposal activities.

9.3.6.4 Clean Water Act Compliance

The discussion at 9.1.4 generally applies to the remainder of the project. A procedural difference (not substantive) may occur if the Army Corps of Engineers (ACOE) becomes a co-proponent of the project. Should this occur as it is anticipated, the ACOE will incorporate measures which otherwise would be imposed through a Section 404(b)(1) permit under the Clean Water Act.

An important standard that applies under 404(b)(1) is that dredged or fill material should not be discharged into an aquatic ecosystem unless it can be demonstrated that such a discharge will not have an adverse impact on the ecosystems of concern. The ACOE has determined that alteration, such as is proposed by this project, will result in "discharges into an aquatic system" which warrant the applicability of Section 404 (b)(1) standards. Requirements include:

- consideration of practicable alternatives;
- delineation of the wetland resource areas;
- evaluation of various physical and chemical parameters that characterize the non-living environment of the site;
- assessment of any special characteristics that might be affected by the proposed use of the site;
- evaluation and testing to determine the possibility of chemical contamination or physical incompatibility of the material to be discharged; and
- determination of appropriate means to minimize the environmental impacts of the discharge.

Alternatives to the work proposed are discussed in Section 2. Wetland resources were delineated and accepted by the Boston and Brookline Conservation Commissions (Appendix L). Existing conditions, including a description of the non-living environment are described in Section 4. An analysis of impacts is contained in Section 6 which also summarizes the sediment and water quality testing that was conducted and which is reported on extensively in Appendices F and G. Environmental mitigation is described in Section 7.

9.3.6.5 Massachusetts Endangered Species Act

The Massachusetts Natural Heritage and Endangered Species Program was consulted and has determined that a permit under the Massachusetts Endangered Species Program is not required. See Appendix L.

9.3.6.6 Section 106 of the Historic Preservation Act

The Section 106 process outlined above also would apply to the remainder of the project which, like Charlesgate, is both listed on, *and* near buildings or districts which are listed or eligible for listing on, the National Register of Historic Places. An overview of historic resources in the project area can be found in Section 4. As with the Charlesgate section of the project, an important goal of the remainder of the project is historic rehabilitation. The 106 review process includes roles for the Massachusetts Historical Commission, the Boston Landmarks Commission, and the Brookline Preservation Commission.

9.3.6.7 MEPA Annual Update

Table 9-7 below provides a proposed outline for the Annual Updates required under the Special Review Procedures. They must be filed annually as a means of informing the Secretary and the public of progress on project implementation, monitoring and effectiveness of mitigation and replanting.

Table 9-7

PROPOSED SCOPE OF THE MEPA ANNUAL UPDATE

1.0 General

  1.1 Project Description

  1.2 Provide a list and description of project work (construction, planning, maintenance or BMPs) and the Phase that was accomplished in the previous year under each of the Project Objectives. Also include deferred work.

  1.3 Provide a list and description of project work and the Phase that is to be conducted in the following year including deferred work for each of the Project Objectives.

2.0 Environmental Mitigation

  2.1 Describe the environmental impacts that are anticipated in the following year's work for each of the Project Objectives. Summarize the mitigation measures in place or planned.

  2.2 Provide a description of the success of the Environmental Mitigation and how it is or, is not, meeting the Project Objectives, any failures and significant observations that were made during the monitoring.

  2.3 Describe any modifications to the Environmental Mitigation that would make it work better.

3.0 Management and Maintenance Plan

  3.1 Describe any changes that have taken place to the Emerald Necklace management structure over the past year.

  3.2 Provide a tabular summary of the effectiveness and success of the growth of new trees, shrubs and wetland plantings.

  3.3 Document any decrease or increase in fish and wildlife usage of the Project area that was observed by Park Rangers, management, crews and/or biologists every other year.

3.4 Describe the success of the Management and Maintenance Plan in controlling the reestablishment of invasive vegetation.

3.5 Where the survival/growth of new plantings and/or control of invasives was unsuccessful, describe the reasons and proposed modifications intended to address this shortfall.

3.6 Objectively describe any short-comings and recommendations for the Management and Maintenance Plan.

4.0 Best Management Practices Plan

4.1 List all BMP activities from the proposed DEIR program that have taken place during the previous year, as well as those which were deferred.

4.2 List all BMP activities that are planned for the following year.

4.3 Include the volume (weight) of sand that was removed from each of the grit separator type devices in the watershed.

4.4 Have there been any problems with BMP enforcement over the previous year and what are the corrective actions?

5.0 Environmental Permits and Approvals

5.1 Provide a working list of all in-place environmental permits and approvals that are required to implement to following year's activities.

5.2 Describe any amendments to, or additional permits and approvals that are needed to implement the following year's work.

6.0 Funding and Schedule

6.1 Provide an overview of the funding status and implementation schedule for the following year's work.

7.0 Response to Agency and Public Comments

7.1 Provide a summary of responses to public comments that were received on the previous public document and a summary of public outreach efforts during the previous year. The Annual Update will be discussed with the CAC.

10

Section Ten

Section 10
Funding Strategy

The funding strategy for the Muddy River Restoration Project is divided into two distinct but related components: 1) the capital funds needed to implement the project; and 2) the ongoing operation and maintenance funds needed to protect the capital investment into the future. Sections 10.1 through 10.14 address the potential sources of capital in order of priority. Section 10.15 identifies the annual funding needed for maintenance, both in the parks and for the BMP program in the watershed. Section 10.16 discusses the role of public/private partnerships for the project.

10.1 Overview

The funding strategy for the Muddy River Restoration Project includes a mix of federal, state and municipal sources. The mix of funds received to date is illustrative of the mix of sources anticipated to provide the additional funds. The state and municipal governments have already funded over $3.4 million towards the project.

10.1.1 Funding Received to Date

Over $7.9 million in funding is currently available to the proponents. Table 10-1 includes the funding sources to date and Figure 10-1 illustrates the mix in a pie chart.

Table 10-1
Funding Allocated To Date

Source	Amount
Federal Emergency Management Agency (FEMA)[1]	$2,248,640
US Housing and Urban Development (HUD)[2]	$2,302,434
Mass. Department of Environmental Management (DEM)[3]	364,700
Boston Water and Sewer Commission	$1,500,000
Town of Brookline	$500,000
Total	**$6,915,774**

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[1] The FEMA funds were a block grant to the state. Massachusetts Emergency Management Agency (MEMA) and DEM allocated the funds to the Muddy River Restoration Project.

[2] The HUD funds were a community block grant to the state. MEMA, DEM, and the Office of Community Development allocated the funds to the Muddy River Restoration Project.

[3] DEM has been appropriated at total of $1,500,000 for the Muddy River project. To date, only $364,700 has been transferred to the proponents. See section 10.7.2 for more details.

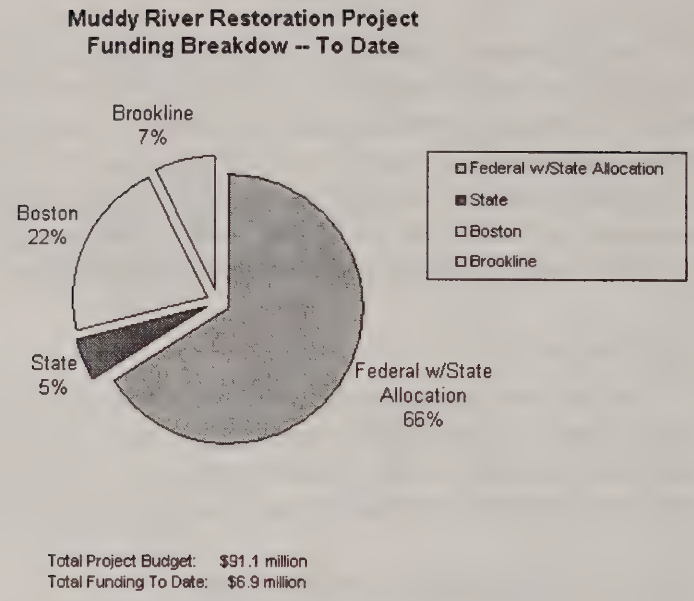

Figure 10-1
Funding Breakdown – To Date

10.1.2 Additional Capital Funding

The estimated total cost of the Muddy River Restoration Project is $91.1 million (see Table 5-10). Subtracting the approximate $7 million in funds received to date and allocated to the project, the additional capital funds amount to approximately $84 million. This funding will include the design and construction of the remainder of the project (upstream of Charlesgate) and the capital costs for the treatment control or "structural" BMPs in the watershed.

Commitments have been made for Federal, state and municipal funding to provide the additional capital costs. The U. S. Army Corps of Engineers has been authorized by the Congress in the Water Resources Development Act of 2000 (WRDA 2000) to undertake the Muddy River project for flood damage reduction and environmental restoration. Also, the Commonwealth of Massachusetts has committed to providing significant capital funding. The municipalities of Boston and Brookline, having been partners with the state and federal agencies in funding the first $7 million, will continue in that role of providing capital funds to supplement the federal and state sources. Finally, the City of Boston and the Town of Brookline, co-proponents, in partnership with the Commonwealth are committed to exploring other potential federal, state and local funding sources to supplement the major funding sources.

10.1.3 Maintenance Funding

As outlined in the Memorandum of Understanding (MOU), the City of Boston and the Town of Brookline will fund the necessary maintenance to protect the capital investment of this project. This includes annual costs of the necessary park maintenance and the Best Management Practices (BMPs) program.
The Metropolitan District Commission (MDC) is responsible for maintenance of a portion of the Emerald Necklace parklands in the project area (Charlesgate, the former Kelly rink area, and a narrow band along the parkways), as well as the parkways (e.g., The Fenway, Park Drive, The Riverway and The Jamaicaway). In order to apply consistently the recommended level of maintenance and BMPs to all portions of the parklands and parkways, this report recommends that an appropriate level of funding be provided for park maintenance and BMPs in the MDC-controlled portions of the park and parkways.

Once the necessary infrastructure improvements are made to the Muddy River, other elements of the Emerald Necklace will be restored in accordance with the Master Plan. It is anticipated that through the work of the Emerald Necklace Conservancy, the Parks Partners program, and other private-public partnerships, local institutions, corporations and individuals will participate in the funding of these improvements and of their subsequent maintenance needs.

10.2 Committed and Potential Funding Sources

Potential funding sources can be classified as committed sources or supplemental sources. The committed funding sources include the U.S. Army Corps of Engineers, the Commonwealth of Massachusetts, the Town of Brookline, and the City of Boston. These entities will fund most of the project.

Supplemental sources include other agencies that could provide grants or loans as a smaller contribution to either the capital or maintenance costs for the project. Sources of funding for the project differ significantly in how much money they could contribute, and the probability that the funds could be obtained. Table 10-2 summarizes information on each funding source including funding agency, amount of funds, probability of capture, and match requirements. The sources are prioritized in terms of their potential to contribute to the project.

Good Potential. These sources have good potential in terms of ability for significant contributions (i.e., $1 million to $5 million) or the favorable probability of committing and receiving funds:

- Environmental Protection Agency (State and Tribal Assistance Grants; Environmental Management Program)
- State Executive Office of Environmental Affairs (EOEA) via the Mass. Department of Environmental Management (DEM);
- State Revolving Fund;

Table 10-2
Funding Sources

Funding Source	*Program*	*Awarded to Date*	*Match*	*Potential for Future*	*Range of Likely Funds*
Committed Funding Sources					
U.S. Army Corps	WRDA	$0	65% to 35%	Good	Up to $32 million**
U.S. Army Corps	EWDA	$0	65% to 35%	Good	Up to $32 million**
City of Boston	Capital Planning	$1,500,000	n/a	Good	To be determined
Town of Brookline	Capital Planning	$500,000	n/a	Good	To be determined
Mass. Special Legislation/State Bonds	General Obligation	$0	n/a	Good	Up to $100 million
Funding Sources with Good Potential					
Environmental Protection Agency	STAG	$0	55% to 45%	Good	Up to $2 million**
Environmental Protection Agency	EPM	$0	95% to 5%	Good	Up to $1 million**
MA Department of Environmental Mgt.	Capital Planning	$364,700	75% to 25%	Good	To be determined
State Revolving Fund	Loan-not grant	$0	n/a	Good	Up to $20 million
Funding Sources with Limited Potential					
Demonstration Grants	Section 319	$0	varies	Good	Up to $300,000
National Park Service	Various	$0	varies	Good	Up to $1 million
National Endowment for the Arts, Humanities	Various	$0	1-to-1	Good	Up to $100,000
U.S. Housing and Urban Development	CBDG	$2,302.43	n/a	Poor	Limited
Federal Emergency Management Agency	HMGP	$2,248,640	75% to 25%	Poor	Limited
Private Institutions	ad hoc	$0	n/a	Good	To be determined
Subtotal		$6.915,774			

Notes:

** Funding is typically up to $ 7 million but Congress can earmark significantly more based on local and political support.

Funding contributed to date by Boston were from Boston Water & Sewer Commission.

Funds contributed to date by Brookline were from Department of Public Works.

Limited Potential. The potential for these sources is limited by either the amount of money each could provide (i.e., typically less than $500,000) or the low probability of obtaining funds, or both.

- Demonstration Grants (Mass. Section 319);
- National Park Service (Urban Park and Recreation Recovery Program; Rivers Trails and Conservation Assistance Grants, Land and Water Conservation Fund, Save America's Treasures Fund);
- National Endowment for the Arts, National Endowment for the Humanities, etc.
- U.S. Housing and Urban Development (Community Development Block Grants);
- Federal Emergency Management Agency (Hazard Mitigation Grants);

Note that the funding strategy does not go into explicit detail on follow-up steps for the Limited Potential funding sources. The funds available from these sources tend to be small, when compared with the size of the capital costs of the overall project. The intent of the Funding Strategy is to prioritize and focus the proponents' efforts on obtaining the greatest amount of funding, which will come from the committed sources, and to a lesser extent, the sources considered as Good Potential. Nevertheless, the proponents will pursue these Limited Potential sources wherever it is appropriate. Any funding that could help defray either the capital or maintenance costs will be considered and pursued, no matter how small.

10.3 Committed Funding Source: U.S. Army Corps of Engineers

10.3.1 Description of Programs

The Water Resources Development Act (WRDA) and the Energy and Water Development Appropriations Act (EWDA) authorize and appropriate, respectively, a wide variety of environmental and aquatic ecosystem restoration and project studies: riverine, estuary and coastal restoration; wetland restoration; water supply and conservation, habitat restoration, non-structural flood damage reduction, erosion control, sediment disposal and management. Unlike other federal agencies, the Corps does not issue traditional grants or loans directly to state or local governments. Congress directs funds towards specific projects, and the Corps combines the federal monies with non-federal matching funds to execute the Congressional directive. Combining military and civil works functions, the Corps in recent years has had an annual budget of approximately $11 billion.

10.3.2 Actions Taken To Date

The Corps is already actively involved in the Muddy River project. A summary of this involvement includes:

- WRDA 1999 authorized a Corps study that concluded in June 2000 that the project meets Corps requirements;

- WRDA 2000 authorized the Corps to carry out the project subject to conditions in the June 2000 report;

- WRDA 2000 appropriated the funds for the Corps to prepare a Decision Document to determine the level of federal involvement in the project. A draft of that document is due in December 2001.

Each of these authorizations/appropriations is discussed in further detail below.

The WRDA 1999 bill authorized the Corps to evaluate a comprehensive plan for the Muddy River and determine if Corps involvement was justified based on the criteria of the project being technically sound, cost effective, and environmentally acceptable. The Corps' report ("Phase I Muddy River Master Plan, June 2000") concluded that the project satisfies all Section 205 program requirements and the Corps should proceed with additional feasibility studies, although current documentation is insufficient to recommend implementation.

In addition, the project proponents, working closely with the congressional delegation, secured authorization of $500,000 for the Muddy River Restoration Project as part of WRDA 2000. The Act authorizes the Corps to :

> *"...carry out the project for flood damage reduction and environmental restoration, Muddy River, Brookline, and Boston, MA substantially and in accordance with the plans, and subject to the conditions, described in the draft evaluation report of the New England District entitled "Phase I Muddy River Master Plan, dated June 2000."*

The conditions in the authorization reference conditions in the June 2000 report requires the Corps to prepare a Decision Document to determine what level of financial involvement the Corps can justify based on its formal policies and procedures. On February 2, 2001, the project proponents and others met with the Corps to discuss the information requirements. The Corps will further evaluate alternatives for flood control and aquatic ecosystem restoration. The Decision Document will include the recommended Federal Project and the Local Preferred Project and the level of funding justified under Corps policy and procedures. If the Local Preferred Project is what the project proponents want, then the Corps would only fund those elements of the project up to the Corps funding commitment on the Federal Project. A draft of the Decision Document is expected to be available in December 2001, and a Final Decision Document completed several months later. A "Working Team" will be formed to coordinate the development of the Decision Document. The Working Team will be made up of a subcommittee will meet monthly.

The EWDA 2000 bill appropriated $500,000 for the Corps to proceed with the Muddy River Project, subject to a determination that the project satisfies all Section 205 program requirements. The federal funding limit under Section 205 is $7 million per project with the structural flood control costs shared with a 65:35 Federal/non-Federal split. However, Congress can earmark considerably more money for any given project if proper justification and political support exists within a district.

The Corps has provided significant funding on several projects similar to the Muddy River Project. For example, for the Murrieta Creek (CA) Flood Protection and Environmental Restoration Project, the Corps was directed to use $750,000 to continue pre-construction and design. Total cost is estimated at $90,866,000 with an estimated Federal Cost of $59,063,900 and non-Federal of $31,803,100. For the Rouge River, Wayne County, MI River Restoration, the Corps provided $10 million for two river restoration projects. EPA ($4.9 million through a State and Tribal Assistance Grant) and several communities working together have also financially supported the project. The project involves restoring the concrete trapezoidal channel the Corps originally built to its natural condition, adding a river walk, excavating portions of the flood plain to maintain adequate hydraulic conveyance, and eliminating combined sewer overflows and illicit connections. The overall project cost is estimated to be about $1 billion. The project has received approximately $500 million in federal, state, and local grants to date.

Other significant milestones in the pursuit of Corps funding for the Muddy River include:

April 24, 2001 – The project proponents met with both the congressional delegation and the Corps in Washington, D.C. to discuss earmarking funds for the 2003 federal fiscal year.

May 15, 2001 – The project proponents met with Lt. General Robert Flowers in Boston and Brookline. Lt. General Flowers, who heads up the Corps nationwide, also made a site visit to better understand the project and the funding needs.

September 9, 2001 – The proponents met with Mr. Larry Prather from Corps Washington D.C. headquarters to discuss project and Corps participation. Project proponents escorted Mr. Prather on a site visit of the Muddy River.

October 5, 2001 – The project proponents met with Mr. Sam Tosi, director of planning for the Corps of Engineers North Atlantic Region (New York office accompanied by representatives from the Corps' New England District. The purpose of the meeting was to determine the schedule of milestones that need to be met to obtain funding, as well as identify follow-up activities for the project proponents to undertake to facilitate and support the Corps' efforts, as described below.

10.3.3 Follow-Up Activities

The present schedule of activities is as follows:

January 2002	Draft Decision Document issued
Spring 2002	Final Decision Document issued

Based on the meeting with Mr. Tosi, other actions that will be taken include:

- Obtain Directed Funding in FY 2003, which will actually be negotiated in spring 2002. This will require briefing the Boston/Brookline Congressional Delegation early in 2002.

- Modify WRDA's 2000 authorization to take into consideration non-federal funding spent to date. The modification must take place in the February/March 2002 period. The Project Proponents need to brief the delegation and identify who will work to include this language in WRDA 2002.

- Verify that the HUD funding to date (which consists of community block grants dispensed at state discretion) can be considered non-federal funds that can be used to meet the Corps' matching funding requirement.

- Encourage state fish and wildlife agencies to write letters of support for this project and send them to the Corps. (First meeting scheduled for November 29, 2001.)

- Conduct bi-weekly meetings with the Corps to discuss status of Decision Document and inclusion of the locally preferred project.

The Corps will attend one Muddy River Technical Advisory Committee meeting each month to update the project proponents on the status of the Decision Document. The Final Decision Document will include an estimate of what level of funding the Corps can provide to the project.

10.4 Committed Funding Sources: Boston and Brookline

10.4.1 Description

Boston and Brookline have jointly committed to funding proportional shares of the Muddy River Restoration Project, including the construction phase and the ongoing maintenance and best management practices to sustain it. Boston and Brookline, in cooperation with the Commonwealth, are fully committed to coming up with the non-federal share of the entire project.

10.4.2 Actions Taken To Date

Boston and Brookline have already demonstrated how effective their partnership can be by jointly funding $2.0 million for the project to date. Brookline's Department of Public Works directly contributed $500,000 to this project, and the Boston Water and Sewer Commission has contributed $1,500,000. Boston and Brookline have also undertaken other projects related to the Emerald Necklace and the Muddy River not specifically included in the Muddy River Restoration Project.

Boston

Boston has spent almost $50 million on projects in support of the Muddy River Restoration Project. The objectives of these supporting projects include the improvement of water quality and implementation of BMPs in the storm drainage infrastructure contributory to the Muddy River. The projects include the removal of sewer cross connections, separating sanitary sewers, developing stormwater master plans, as well as improving catch basin cleaning and street sweeping.. Representative projects include:

- $90,000 to remove 30 illegal connections to Muddy River (between 1990 and 1999)
- $70,000 from the Boston Parks and Recreation Department to install the Jamaica Pond particle separator (1993)
- $70,000 to install the Muddy River Diversion gate (1995)
- $33,600 to install the Frances Street siphon (1998)
- $4,100,000 from the BWSC to develop and implement catch basin maintenance program (2001 to 2003)
- $5,500,000 from the BWSC to clean the Stony Brook conduit (2002-2003)
- $300,000 from the BWSC to clean the Boston Gatehouses in the Fens (2001)
- $1,500,000 from the BWSC to eliminate illegal connections to the Stony Brook Conduit (from 1999 to 2002)
- $1,500,000 from the BWSC to replace and rehabilitate sewers and storm drains in the Longwood Medical Area (2001-2002)

Brookline:

Brookline has recently spent over $5 million to do similar projects with the same common objectives of water quality improvement and implementation of BMPs in the Muddy River watershed. These include::

- $900,000 to remove 50 sewer cross connections in Tannery and Village Brooks (1989-1997)
- $75,000 to investigate and remove cross-connections at Longwood (1995)
- $900,000 to restore a bridge in the park (1997)
- $350,000 to develop stormwater and wastewater master plans (1998)
- $1,000,000 to restore Olmsted Park (jointly funded with DEM and HUD)

Boston and Brookline have demonstrated their commitment to improvements in the Muddy River watershed and the parks by an investment of $55 million between 1990 and 2002. This $55 million in municipal spending supports three of the objectives of the Muddy River Restoration Project:

-- improvement of water quality (in the Muddy River)

-- implementation of BMPs

-- historic preservation in the park

10.4.3 Follow-up Activities

Boston and Brookline are committed to providing capital funds for the Muddy River Restoration Project. The exact amounts cannot be authorized without local government approval. Section 10.15 provides what proportional contributions can be expected based on expected contributions from the Corps, match requirements, and the park acreage in each municipality.

In addition, Boston and Brookline will continue to commit funds for other capital improvements in the watershed not specifically included in the Muddy River Project. Capital improvements presently planned by Brookline and Boston include:

Boston:

- $2,100,000 by the BWSC to construct improvements to the Boston gatehouses in the Fens

Brookline:

- $210,000 to dredge the mound at Leverett Pond
- $300,000 to provide landscape improvements to Allerton Overlook
- $400,000 to improve and restore Babbling Brook
- $1,200,000 to separate sewers on Walnut Street
- $30,000 to reconstruct sewers on Monmouth Street
- $500,000 to remediate Willow Pond

In additional to these capital projects, both municipalities have the responsibility to maintain and management the park system on an annual basis. The expected range of expected annual park costs is **(from Tim Marshall's report)**.

As part of the program to sustain the improvements of the capital project, Brookline and Boston have committed to undertaking Best Management Practices (BMPs) in the watershed.

10.5 Committed Funding Source: Massachusetts Special State Legislation

10.5.1 Description of Program

The project proponents will seek a one-time grant from the Commonwealth in the form of special legislation for a contribution to the Muddy River Project. The Commonwealth could then issue general obligation bonds to provide funds for the project. The Commonwealth limits the amount of debt it will issue for a capital project like the Muddy River in order to preserve the rating of the Commonwealth's bonds. The present demand for capital projects exceeds the Commonwealth's fiscal capacity due to several factors including: 1. the Central Artery project has taken the major share of available capital resources from other projects with impacts likely to be felt for the next 10 to 15 years; 2. Massachusetts' already high debt limits the ability to initiate new bonding.

Nevertheless, new projects can and do get funded if the political will and support exists to aggressively promote them. For example, despite the problems with the Big Dig, in August 2000 then-Governor Paul Celucci signed a bill authorizing the expenditure of $312 million in public funds to pay for the infrastructure and land needed for the new Fenway Park. The Muddy River Project is one of the most ambitious and comprehensive urban river restoration projects in the country. With its multiple objectives of flood control, water quality improvements, habitat enhancement, historic landscape rehabilitation and installation of Best Management Practices, this is a truly unique public works project that will benefit many. These include the residents, institutions and businesses that experienced flooding, the MBTA and its riders whose service is disrupted by high water in the river, and visitors from near and far to this unique, National Landmark park. As such, this project deserves the financial consideration and political support of the Commonwealth.

10.5.2 Actions Taken To Date

The project proponents have actively explored securing capital funding for the project from the Massachusetts delegation. On April 4, 2001, the proponents met with Ms. Stacey Rainey, the Governor's Chief of Staff to discuss funding options. In addition, the project proponents have met with representatives in state government including the EOEA to discuss the project's status and progress that has been made in pursuing other funding sources. In addition, on October 23, 2001, the Boston and Brookline Delegation met at the State House.

10.5.3 Follow-up Activities

The project proponents will conduct follow-up meetings with state officials to begin the process to obtain a one-time grant from the state through special legislation. The proponents presently plan to meet with House Speaker Finneran and other representatives to maintain the political momentum already created for the project.

10.6 Good Potential: Environmental Protection Agency

10.6.1 Description of Programs

In the past decade, Congress has been adding specific line items to the EPA's budget for projects in various congressional districts. These projects are typically funded under the State and Tribal Assistance Grants (STAG) and Environmental Programs and Management accounts (EPM). Last year, Congress appropriated $475 million for more than 200 projects in the STAG account, and over $100 million in the EPM account. The STAG money comes in the form of a 55% federal grant. The EPM money comes in the form of a 95% federal grant, although the overall amounts tend to be lower than STAG grants. Money from STAG and EPM grants has been used to fund a number of projects similar to the Muddy River Project such as river restoration. As described above, the Rouge River Restoration Project recently received $4.9 million in STAG monies.

STAG appropriations for Massachusetts communities for FY 2001 included $2,000,000 for wastewater projects in Bristol County, $1,000,000 for control of CSOs for the MWRA, and $1,000,000 for water and wastewater infrastructure improvements for Taunton, MA.

10.6.2 Actions Taken To Date

This funding source has not yet been explored.

10.6.3 Follow-up Activities

The project proponents will attempt to have STAG and EPM monies earmarked by EPA for FY 2003. A draft of the letter that will be sent to the congressional delegation stating interest in STAG and EPM monies is included in the appendix. A follow-up meeting will be scheduled in early 2002 with the congressional delegation to develop a strategy to secure whatever funds might be available for a project of this size and scope. These activities will take place in time to be considered for the FY 2003 EPA budget (i.e., by April 2002).

10.7 Good Potential: Massachusetts Department of Environmental Management

10.7.1 Description

EOEA has the authority to issue grant money for a variety of river restoration and flood projects such as the Muddy River Project. The amount of money in these grants can be significant.

10.7.2 Actions Taken to Date

EOEA, through one of its constituent departments, DEM, has been allocated a total of $1,500,000 for the Muddy River Project under two appropriations:

a. 2100-3012-Chpt 289 acts of 1988: $500,000

b. 2100-1122-Chpt 236 acts of 2000: $1,000,000

To date, DEM has transferred a total of $364,700 to the City of Boston (lead proponent) for the Muddy River project. Other amounts have been allocated for other purposes that support the project, such as a flood gage in the river and the facilitation assistance for the CAC meetings. The following is a breakdown of the $500,000 of the 2100-3012 account has all been used to support the Muddy River Project and related activities:

- $364,700 for the Muddy River Restoration Project, transferred to the City of Boston (May and July 2000),
- $100,000 to US Army Corps of Engineers (ACOE) Feasibility Study (funds transferred in April 2000),
- $5,000 to USGS for its stream gage in the Muddy River at Netherlands Road (expended as of June 2000),
- $11,905 to Massachusetts Office of Dispute Resolution (MODR) for facilitation of CAC (expended as of Aug. 2000), and
- $15,299 to for the Charlesgate Study by CDM (FY 1999).

A total of $228,726.76 has been spent out of the $1 million in the 2100-1122 account. This has funded:

- MODR facilitation of the CAC (this includes $25,919 for this year's MODR facilitation work),
- the continuation of the Muddy River USGS gage,
- the Pressley and Associates study, and
- the design and printing of the Muddy River Master Plan. No funds out of this account have been transferred to the City of Boston.

The remainder of the funds ($771,274) in this account remains unencumbered and may be used for future aspects of the project.

The DEM and the Massachusetts Emergency Management Agency (MEMA) had actively sought and successfully obtained the FEMA and HUD funding amounting to over $4.5 million of federal block grant contributions received to date. DEM and MEMA are also responsible for allocating these federal funds to the Muddy River Restoration Project.

10.7.3 Follow-up Activities

The potential for receiving additional funds is being explored.

10.8 Good Potential: State Revolving Fund

10.8.1 Description of Program

The Massachusetts Water Pollution Abatement Trust and Clean Water State Revolving Fund (SRF) assist cities, towns, and wastewater districts in financing water pollution abatement projects, including nonpoint source projects. Historically, the financial assistance took the form of subsidized loans, with the subsidy equivalent to a 50% grant (approximates a 0% interest rate). However, recent changes in the SRF resulted in the interest rate being raised from 0% to 2%. At a 2% interest rate, the loan is equivalent to about a 25% grant. In 2001, seventy-four towns, cities, wastewater districts and water suppliers will receive $321 million in state loans for environmental infrastructure and planning improvements.

The SRF is a loan that must be paid back, not a grant. Thus, it does not provide a direct source of funds for the Muddy River project. Nevertheless, the loans are typically at low interest and can be paid off over a long period (e.g., twenty years). The SRF does potentially factor into other funding sources and should be included in the overall funding strategy. For example, one of the criteria in the EPA STAG process asks whether the communities have applied for an SRF loan. The size of SRF loans is usually significant. In 2000, two non-point source projects in Quincy (Quincy Shore Drive Improvements) and Cambridge (Beacon Street Stormwater Management) received loans of $10,507,000 and $9,703,000, respectively. Applications for 2002 are due June 30, 2001.

10.8.2 Actions Taken to Date

It was premature to explore use of bonds and the SRF without knowing the final capital costs of the Muddy River Project. Consequently, this source had not been previously evaluated.

10.8.3 Follow-up Activities

The SRF can be explored if necessary once the DEIR receives the necessary approvals.

10.9 Limited Potential: Massachusetts Demonstration Grants

10.9.1 Description of Program

There are a number of sources of funds to conduct demonstration projects such as the evaluation of particle separators in the watershed. Potential sources include Massachusetts' Department of Environmental Protection (MADEP) Non-Point Source Implementation Grants (319 Program).

Types of eligible 319 projects include: subwatershed projects that address all major identified nonpoint sources affecting water quality; demonstration projects that accelerate the transfer and adoption of new or innovative BMPs, technologies or institutional approaches to controlling NPS pollution; groundwater projects that target high priority statewide NPS groundwater problems; in-lake projects which address the control of NPS pollution from lake watersheds; and watershed resource restoration projects that restore vegetated wetlands, lakes, rivers, streams, estuaries, shorelines, riparian areas, seagrass beds and other aquatic habitats. Grants typically range from $75,000 to $300,000. Boston and Brookline intend to submit applications for this program to receive funds to pilot test and evaluate alternative BMPs.

10.9.2 Actions Taken To Date

Boston and Brookline have applied for and obtained Section 319 grants in the past. Three particle separators have been installed in the Muddy River watershed to date.

10.9.3 Follow-Up Actions

Boston and Brookline will continue to pursue these grants in the future. Before seeking additional funds for other projects, however, each municipality intends to conduct engineering evaluations to determine how the performance of existing separators can be improved.

10.10 Limited Potential: National Park Service (NPS)

10.10.1 Description of Programs

NPS has funds available in several programs. The NPS' "Save America's Treasures" program provides funding opportunities for the preservation needs of the nation's most significant historic sites. Grants are administered by the NPS in partnership with the NEA. The NPS administers grants for historic structures and sites, including historic districts, sites, buildings, structures, and objects. Since 1999, 238 grants totaling $94 million have been awarded (about $400,000 per project). Recent grants ranged from $50,000 to $1.1 million. Selection criteria require that each project be of national significance, demonstrate an urgent preservation need, have an educational or clear public benefit, and demonstrate the availability of likely matching funds (50:50).

The Urban Park and Recreation Recovery Program provides matching grants to local governments to develop local park and recreation system recovery plans. Eligible activities include resource and needs assessments, citizen involvement and planning, and program development to encourage public definition of goals. Historically, this program has been poorly funded, providing only $4,000,000 in 2000. Community Development Block Grant program funds may be used as part of the local match.

The NPS's Rivers, Trails and Conservation Assistance Grants Program provides staff assistance to support partnerships between government an citizens to increase the number of rivers and landscaped protected and trails established nationwide. In the past, this program has funded projects to develop new trails and greenways; protect and restore river resources, access and views; convert abandoned railways to multi-purpose trails; promote and develop systems of trails and greenways; conserve open space; establish new conservation organizations and alliances. In 2000, the program provided $10,460,000 to eligible communities.

10.13 Limited Potential: Federal Emergency Management Agency

10.13.1 Description of Program

The Hazard Mitigation Grant Program (HMGP) was created in November 1988, by Section 404 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act. The HMGP assists States and local communities in implementing long-term mitigation measures following a presidential disaster declaration. The objectives of the HMGP are:

- To prevent future losses of lives and property due to disasters;
- To implement State or local mitigation plans;
- To enable mitigation measures to be implemented during a State's or community's immediate recovery from a disaster; and
- To provide funding for previously identified mitigation measures that benefit the disaster area.

To meet these objectives, FEMA can fund up to 75 percent of the eligible costs of each project. The State or local cost-share match does not need to be cash; in kind services or materials may also be used. With the passage of the Hazard Mitigation and Relocation Assistance Act of 1993, Federal funding under the HMGP is now based on 15 percent of the Federal funds spent on the Public and Individual Assistance programs (minus administrative expenses) for each disaster.

The HMGP can be used to fund projects to protect either public or private property, so long as the projects in question fit within the State and local government's overall mitigation strategy for the disaster area, and comply with program guidelines. Examples of projects that may be funded include the acquisition or relocation of structures from hazard-prone areas, the retrofitting of existing structures to protect them from future damages; and the development of State or local standards designed to protect buildings from future damages.

In order to apply for HMGP project funding, applicants must work through their State, since the State is responsible for setting priorities for funding and administering the program.

10.13.2 Actions Taken to Date

The Muddy River Project has received $2,248,640 in FEMA HMGP grants to date. The money is targeted for dredging Charlesgate. The money was earmarked for mitigation based on the damage incurred in the two major rainstorms in 1996 and 1998.

10.13.3 Follow-up Actions

Additional funding is unlikely unless another significant rain event triggers a presidential disaster declaration. However, funds appropriated but unused in other FEMA projects could, at the discretion of MEMA, be re-assigned for the Muddy River project. Presently, opportunities exist to re-assign monies in this fashion, although the exact amount will not be known until the end of 2001.

10.14 Summary of Capital Funding

The framework of the funding strategy is built on the current commitments by federal and state sources. For example, the U. S. Army Corps of Engineers has been authorized by the Congress in 2000 to undertake the Muddy River project. Also, the Commonwealth of Massachusetts has committed to providing significant capital funding.

The City of Boston and the Town of Brookline, co-proponents, in partnership with the Commonwealth are fully committed to obtaining funding to supplement the anticipated federal funding. The funding mix to date (see pie chart in Figure 10-1) demonstrates that all parties have been able to cooperatively provide the local matches for all federal funds received to date.

Based on preliminary funding information from the Corps and discussions with representatives from the Town of Brookline, City of Boston, and the Commonwealth of Massachusetts, an order-of-magnitude outline of proportional contributions from the committed funding sources is presented here. The following is one example of how funding might work, assuming a traditional publicly funded capital effort. This example does not rule out other possible variations that would tap the other various public or private funding sources mentioned in this Section. The availability of such sources could reduce the amounts of funds to be provided by the state and municipalities.

At this time, the Corps of Engineers is preparing its Decision Document that will determine the extent of the Corps' funding participation in the project, based on its mandates relative to flood control and environmental restoration. Part of this document will be a detailed cost estimate. The Corps' cost estimate is not available at this time, but should be made public early in 2002. Therefore, at this time, only an order-of-magnitude outline of the funding split can be presented below. When the Corps' estimate is made public, this funding outline will be updated accordingly. The estimated total cost of the Muddy River Restoration Project is \$91.1 million with \$6.9 million in funds received to date[1] and allocated to the project. Thus, the additional capital funds amount to approximately \$84.2 million. The basis of the outline is as follows: the estimated cost of flood improvements at the time of the Memorandum of Understanding (MOU) was \$43.2 million, with the expectation that the Corps would contribute 65% ($28 million) and that the Commonwealth of Massachusetts would contribute 35% ($15.2 million).

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[1] The total funds for the project to date are \$7.9 million. Since \$1 million of DEM funds has not yet been transferred to the proponents, the funds *received* to date is \$6.9 million.

This results in a balance of $41.0 million between what was anticipated at the time of the MOU and the current estimate of additional funding needed ($84.2 million minus $43.2 million). The balance of $41.0 million includes $11 million in structural BMPs. It is anticipated based on current discussions that the Corps' preliminary interpretation of its policy would allow the Corps to fund the sedimentation basins included in the BMPs at an estimated cost of $4 million. Thus, non-Corps sources must address approximately $7 million of structural BMPs, bringing that portion of the balance that the Corps can participate in at approximately $34.0 million ($41.0 million minus $7 million). Assuming a similar level of financial participation from the Corps at 65% (or about $22.1 million), then the local funding sources would have to come up with a 35% match (or about $11.9 million), divided between the state and the municipalities.

Adding the structural BMPs that the Corps cannot fund ($7 million) to the match ($11.9 million) represents a total of $18.9 million from non-Corps sources. Since the Corps has not completed its Decision Document, an exact figure cannot be determined at this time. For the purposes of this outline of the funding strategy, an approximate figure of $20 million is used.

An equal partnership (i.e., a 50:50 split) of the $20 million between the Commonwealth and the municipalities would require each to contribute $10 million. Boston and Brookline have discussed what proportion each municipality should contribute for its share of the $10 million, and determined that an equitable sharing would be 87% Boston (or approximately $8.7 million) and 13% Brookline (or approximately $1.3 million).

The contributions of the Commonwealth of Massachusetts would include the 35% match on the initial $43.2 million ($15.2 million) plus the 50:50 share of the subsequent $41 million ($10 million) for a total of approximately $25 million. Note that there are $1 million in funds for the project appropriated for DEM, but not yet transferred to the proponents. If these funds were designated to match the Corps funding, it would reduce the additional state share to approximately $24 million.

Many factors may result in differences between the current estimate and the estimate that the Corps develops. As noted in subsection 10.6, EPA STAG funds are a good potential for federal funds for some of the structural BMPs that the Corps would not fund. Also, funding from other sources such as NPS will be investigated.

In addition, the Corps' cost estimate may likely differ from the current estimate of $91.1 million. The differences may be due to factors such as different methods of estimating construction costs, different construction methods for certain aspects of work (e.g., removal of invasives along the banks), differences in procurement processes, different construction management costs, or different perspectives on the appropriate level of contingencies and allowances for the current level of preliminary design.

10.15 Funds for Operation and Maintenance

Operation and maintenance (O&M) funds are the second key to the success of the Muddy River restoration project. The MOU signed by several parties including the City of Boston and Town of Brookline, commit the City and Town to providing O&M funding over the long term to maintain the improvements constructed as part of this project. The new improvements include new culverts, the dredged river, and new landscaping.

O&M funds have been divided into two categories, O&M for the BMPs constructed or implemented under this project and O&M for the other improvements implemented under this project. The other improvements include such things as the flood control infrastructure, dredging and landscape maintenance. All O&M costs are based on future costs with the project in place.

A detailed listing of the O&M activities and costs are included in Section 8. O&M for the BMP s implemented as part of this project amount to approximately $259,000 per year split between Boston, Brookline and the MDC. O&M for the non-BMP improvements for the project amount to approximately $1,316,000 per year also split between Boston, Brookline and the MDC. A large part of the non-BMP O&M is park maintenance ($1,040,000). The cost carried in this section is the estimated value of park maintenance including labor, equipment, and supplies. By meeting some of these costs through volunteers, donations, in-kind service or increased efficiencies, the actual cost on agency budgets is expected to be less.

The MDC's participation in O & M for both BMP and non-BMP improvements will have a significant impact on the success of the project; however the MDC is not a project proponent, and the agency will have to define its own level of commitment.

A summary of the annual O&M costs broken out by entity is included below. A portion of the O&M costs are already being funded by the entities so that the additional O&M cost due to this project are less than the total presented. The difference in total versus current O&M costs are also presented on below showing the anticipated increase in O&M costs to the project proponents. Estimating actual funds currently being spent is quite difficult since some of these costs are in maintenance budgets, some in capital budgets and some in other cooperating departments or agencies. The largest current value was assigned to the current level of FTE on the existing park maintenance staff.

The project proponents agree that the level of maintenance described in Section 8 is appropriate. The proponents will seek to fund this level of maintenance, subject to appropriation and the availability of funds. The proponents have already begun to address some of the maintenance recommendations. In recent months, Boston and Brookline have begun a joint training program for maintenance crews at the Arnold

Summary of O & M Costs			
	Future Value	Estimated Current Value	Additional Budget
Boston	$858,400	$330,000	$528,400
Brookline	$436,100	$129,000	$307,100
MDC	$280,500	$57,000	$223,500
Total	$1,575,000	$516,000	$1,059,000

Arboretum. Boston has created an historic parks unit with a director, project manager for the Parkman Fund and assistant project manager. This unit works closely with partners in both the public and private sectors, in cooperation with BPRD's General Superintendent of Horticulture and city arborists. The Department has also reconvened it woodlands committee at the staff level. In Brookline, a recent shift to zone management resulted in a crew whose zone includes Brookline's portion of the Emerald Necklace. Both Boston and Brookline remain committed to closing the maintenance gap identified in Section 8.

10.16 The Role and Commitment of Private Institutions

In the private sector, there are numerous educational, cultural and medical institutions that are interested in upgrading the parkland and surrounding neighborhoods, and increasing flood protection along the Muddy River. These institutions could provide volunteers, funds for maintenance, or in kind services.

Preeminent among the organizations to assist in forging public/private partnerships is the Emerald Necklace Conservancy. The Emerald Necklace Conservancy is a public-private partnership composed of community, business, government, and institutional representatives, residential neighbors, and interested citizens. The Conservancy was created to restore, preserve, and promote the landscape and waterways of the Emerald Necklace as special places for people to enjoy. The Conservancy's primary focus is on program development and implementation, public education, advocacy, and constituency-building initiatives. The Conservancy could play a role in assisting in raising funds for the Muddy River Restoration Project. Given its historical role in promoting landscape restoration, it is likely that the Conservancy will continue to supplement and complement public sector efforts for restoration of the Necklace primarily in the areas of landscape improvements, maintenance and monitoring through extended private-public partnerships.

Emmanuel College has expressed a willingness to commit upwards of $100,000 to restore the park landscape abutting its property. Other institutions, including Northeastern University, have expressed interest in providing assistance in monitoring and maintaining project improvements. Institutions could be a source of capital funding, provide a role in helping to defray the costs of monitoring, and support maintenance of park improvements. The proponents review all work conducted within 100 feet of the Emerald Necklace, which provides an opportunity to explore common goals for the parks with a large number of educational, cultural and medical institutions. Public/private partnerships can be forged to have these institutions support some of the maintenance work.

11

Section Eleven

Glossary

Air contaminant	Any substance not normally found in the atmosphere or found in the atmosphere at greater than its natural concentration. The sources for these contaminants may be either natural (as in the case of dust from arid lands) or man-made (as in the case of industrial and automotive pollutants). Significant air contaminants include carbon monoxide, hydrocarbons, particulates, oxides of nitrogen and sulfur, and photochemical oxidants.
Algal	Of or pertaining to algae. Algae are generally microscopic, single or multiple vegetative cells but are distinguished from the higher vascular plants such as grass, bushes and trees.
Alkalinity	The acid buffering capacity of a solution (water).
Ambient	The surrounding atmosphere environment, or conditions.
Amphipod	A small crustacean which is generally flattened in the dorso-ventral plane. Also called scuds.
Anadromous	Refers to a group of fish which migrates from the sea to freshwater in order to reproduce. The adults may die, as in some salmon species, while others live to return to the ocean. The juveniles return to the ocean within the first or subsequent years of their life.
Analyte	The chemical constituent for which chemical analyses are conducted.
Arochlor	The chemical name of polychlorinated biphenyl (PCBs) isomers that are specifically identified by their number, i.e. Arochlor 1260.
Aquifer	Water-bearing soil or rock, noted for having high porosity. A subsurface material in which wells can be expected to yield large amounts of groundwater.
Average daily traffic	The total volume during a given time period in whole days greater than one day and less than one year divided by the number of days in that time period.

A-Weighting	is the method used to represent the human response to he frequency content of a complex sound such as that generated by highway traffic. This weighting measurement stresses the high frequency content of a sound, since people find high frequency noises much more annoying than lower frequency noise.
Bedrock	Rock that is part of the earth's crust and mantle, underlying the soil and surficial material.
Best Management Practices	Practices that can improve water quality in storm drainage systems. Some of these are maintenance operations such as frequent street sweeping and cleaning out of catch basins. These practices might be implemented throughout the watershed. Other BMPs are "structural" and involve first constructing something, and then maintaining it. Examples might include "water quality devices" or buried chambers that help settle out the sand and sediments in the storm drain pipe before it discharges into the water course. Structural BMPs are often located near the end of the pipe, just before the outlet. The EPA and DEP have identified wide variety of BMPs. Not all BMPs are appropriate for every situation.
Biochemical Oxygen Demand	Measure of water quality, showing the oxygen needed by biological organisms (anaerobic bacteria) to remove pollutants from water over a five-day period.
Btu	The amount of heat required to raise one pound of water by one degree Fahrenheit.
Carbon-monoxide	(CO) is a colorless, odorless gas created by incomplete combustion of petroleum fuels. It is the most abundant automotive exhaust component. Transportation sources contribute 74% of the total amount of carbon monoxide released annually in the U. S. The potential effects of carbon monoxide are a function of concentration and exposure time. Its danger to humans arises from its affinity for hemoglobin, the oxygen-carrying red cells of the blood. Federal standards limit the maximum one-hour concentration of carbon monoxide to 35 ppm and the maximum eight-hour average concentration to 9 ppm. These levels are well below the threshold of noticeable effects.

Carbonate	Derived from limestone either as a calcium or magnesium salt.
Chemical Oxygen Demand	Chemical oxygen demand is a measure of the amount of organic matter in a sample that may combine with oxygen. It is used to evaluate the oxygen-depleting effect that a substance (sediment, wastes, etc.) may have on surrounding waters, and is an indicator of the degree of pollution in an effluent.
Chlorinated hydrocarbon	Any compound that contains carbon, hydrogen, and chlorine. Chlorinated hydrocarbons are known for their toxic effects and their persistence in the environment. They have long been used as pesticides, although their use has now been limited since their environmental hazards have been realized (e.g. DDT, Chlordane, Chloroform, and PCBs).
Coliform	A group of bacteria mainly of intestinal origin although there are some strains that are terrestrial.
Community	A naturally occurring assemblage of plants and animals that live in the same environment, are mutually sustaining and interdependent, and are constantly storing, using, and dissipating energy.
Conductivity	A measure of the ability to pass an electric current in a liquid. This indirectly measures the mineral content in a sample.
Curb cut	A break in the curb along the edge of a pavement that defines the edge to vehicle operators. The break or cut allows vehicular egress and ingress between a highway and abutting land.
Daylighting	Involves the uncovering – and, thereby, exposing to daylight – a section of a waterway that had been put in a pipe or culvert.
dBA	The A-weighted decibel, designated as dBA, has been found to correlate very well with people's subjective judgment of noise level.
Decibel (dB)	The customary units for measuring noise strengths. The decibel is a logarithmic unit that relates a sound

intensity to a standard reference sound intensity, as follows:

$$dB=10 \log (I/I_o)$$

The reference level (I_o) is one picowatt (10^{-12} watts), the weakest sound audible to most people. A logarithmic unit is used to measure sound because of the enormous range of intensity to which the human ear is sensitive. The maximum audible sound is ten trillion picowatts. The logarithmic scale allows representation of this range on a scale from 0 dB (one picowatt) to 130 dB (ten trillion picowatts). On this logarithmic scale, a doubling of sound power corresponds to +3 dB. In perceptual terms, 3 dB is about the smallest difference in sound level reliably heard by a human. Ten dB is perceived as a doubling of sound level.

Direct Impact	Effects resulting solely from the proposed project.
Discharge	The release of water from a water resource such as a lake or stream. This is generally a volumetric measurement.
Dissolved Oxygen	A measure of the amount of oxygen in water and usually expressed in parts per million. Dissolved oxygen levels can be directly related to the suitability of the waters for habitation by aquatic biota.
Diversity	In ecological usage, the general variety of organisms present in an area. Commonly categorized into types of diversity such as species diversity, spatial diversity, etc. Species diversity is often used as a measure of the stability of an environment. The most common diversity measure is simply the number of species in an area divided by the total number of individuals of all species.
Dolomite	A carbonate sedimentary rock consisting chiefly (50% by weight) of the mineral dolomite $CaMg(CO_3)_2$.
Ecotone	The interface or edge effect between terrestrial and aquatic environments that provides significant food sources, shelter, breeding and nesting areas for a variety of invertebrates, including dragonflies, butterflies and

	beetles, which in turn provide food sources for all growth levels (larval, pupa and adult) for avian and small mammal species. Environmental Impact Report (EIR) After the Secretary of EOEA determines that an EIR is required, the project proponent prepares the EIR. The EIR is prepared according to the scope outlined in the ENF Certificate and the MEPA Regulations (301 CMR 11.00). The EIR is an analysis of the environmental impacts of the project in technical detail. The EIR itself is not a permit, but it allows the regulatory agencies the opportunity to review the details of the project prior to the permit application stage. The EIR also responds to public comments letters regarding the ENF. The EIR is first submitted to the MEPA Office as a draft (DEIR). A 30-day public comment period follows. The Secretary of EOEA then prepares a Certificate that states whether the DEIR has addressed the scope and environmental impacts adequately. The Certificate provides guidance as to any revisions or additional information is required in the Final EIR (FEIR). The FEIR also responds to public comments letters regarding the DEIR.
Electro-Shocking	A non-lethal fish sampling procedure whereby electrical current that is introduced to the water temporarily stuns the fish which facilitates their netting. The fish are returned to the water after identification and measurements are made.
Endangered Species	Any plant or animal species listed at the federal or state level that is in danger of extinction throughout all or a significant portion of its range.
Environmental Notification Form (ENF)	Its submittal is the first step in the environmental review of a project under Massachusetts Environmental Policy Act (MEPA). The ENF requires the project proponent to answer specific questions regarding the likely environmental impacts of the proposed project. The ENF is submitted to the MEPA Office of the Executive Office of Environmental Affairs (EOEA), which determines if the likely impacts are significant to warrant the submission of an Environmental Impact Report (EIR). The public is encouraged to provide written comments. The findings of the Secretary of EOEA are written in the form of a Certificate. The ENF for the Phase I Muddy River Flood Control, Water

	Quality and Habitat Enhancement was submitted in January 1999. The Secretary of EOEA issued two (2) certificates: A Certificate requiring that an EIR be prepared and specifying the scope of the EIR.; and A Certificate establishing the Special Review Procedure, which included the establishment of the Citizens Advisory Committee (CAC) and defining its role.
Evapotranspiration	The combined loss of water through direct evaporation from an open water surface and the loss of water from plants as part of their physiologic processes.
Extractable Petroleum Hydrocarbons	A MA DEP method to determination the level of contamination due to petroleum components that are extracted from a sample.
Facultative	May live in a polluted or unpolluted environment.
Fecal coliform bacteria	A group of organisms, differing greatly in their sources and habitats which are a reliable indicator of the bacterial pathogenicity of a water sample.
Fecal streptococci bacteria	These organisms are characteristic of fecal pollution and are consistently present in the feces of warm-blooded animals. Unlike fecal coliforms, they do not multiply in water.
Floatables	Materials in water that float such as debris, refuse, leaves, etc.
Floodplain	Land lying adjacent to a river channel that is covered by water when the river overflows its bank. The 100-year floodplain is that area subject to a one- percent chance of flooding in any given year.
Floodway	channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment in order that the 100-year flood can be carried without substantial increases in flood height.
Gabion	Generally a heavy gauge wire gauge that is filled with rock to form a structural revetment along steep embankments and waterways.
Glacial till	Unsorted and unstratified heterogeneous mixture of clay, sand, gravel, and boulders which vary widely in size and shape, and which have been directly deposited

	by and underneath a glacier without the subsequent reworking of water.
Groundwater	That part of the subsurface water that is the zone of saturation, including underground streams. The supply of fresh water under the earth's surface in an aquifer or soil that forms the natural reservoir.
Heavy metals	Metallic elements with high molecular weights that are generally toxic to plant and animal life in low concentrations. Examples are mercury, chromium, cadmium, and lead. They are often residual in the environment and tend to accumulate in organisms.
Heavy molecular weight	Complex organic compounds that do not volatilize, are persistent (or retained) in the environment and can potentially cause cancer risk.
organic compounds	Hydraulic Gradeline The desired height or elevation of water in a stream.
Hydric	Pertaining to permanently moist or wet soil as in wetland soils.
Hydrocarbons	Unburned hydrocarbons (HC) are the product of incomplete combustion of petroleum fuels. They are also derived from direct evaporation of petroleum products, both from automobiles and from the storage, transport, and use of fuels, solvents, and other petroleum products. Although hydrocarbons can cause irritation and other symptoms in humans, they are primarily of concern in that they are one of the ingredients necessary for the formation of photochemical oxidants (smog).
Hydromulching	The process of placing grass or other seed mixtures along with a pulp mulch in a water base. The mixture is sprayed onto the soil that is to be covered. The mulch mixture can be in a green color.
Indirect impact	Project-related impact, such as population changes, not directly attributable to the project itself.
Indirect source	A facility, building, structure, or installation that attracts or may attract mobile source activity that results in emissions of a pollutant for which there is a national standard.

Inorganic nitrogen	A form of nitrogen that is the summation of ammonia nitrogen, nitrite nitrogen, and nitrate nitrogen. The term is generally used in limnologic applications since inorganic nitrogen is the most readily used form of nitrogen by algae.
Kjeldahl nitrogen	The total amount of nitrogen in a sample, as determined by the Kjeldahl method, which involves digesting the sample with sulfuric acid, transforming the nitrogen into ammonia, distilling off the ammonia, and then titrating, or measuring the amount of ammonia.
Leachable	A characteristic of soil and sediment whereby its contaminants can become separated from the medium and be mobilized into a soluble form in water.
Lentic	Flowing water as opposed to lotic water.
Level of Service	A scale that relates the traffic capacity of a road to the volumes utilizing that road. The scale ranges from A which describes a free flow condition where there is little or no restriction of maneuverability, to F, which is a condition of severe congestion and forced flow. Level C is the generally accepted design capacity of a road.
Limestone	A rock that is chiefly formed by accumulation of organic remains, usually shells and coral, that consists mainly of calcium carbonate, though sometimes may contain magnesium carbonate.
Limnologic[al]	The science of fresh water ecology.
Lotic	Water that has none or a sluggish flow.
Macroinvertebrate	The invertebrate species that in habit the aquatic habitat that are generally visible to the eye, not microscopic, and which consist of worms, insects and other species.
Meade	A meadow.
mg/kg	Milligrams per kilogram, these are the units of measurement and express milligrams of contaminant per kilogram of soil.

Mitigation	A method or action to reduce or eliminate project impacts.
Monoculture	Used to denote a vegetated community that consists of only a single plant species.
Muck	Organic silt.
National Ambient Air Quality Standards (NAAQS)	The prescribed level of pollutants in the outside air that cannot be legally exceeded during a specified time in a specified geographic area.
National Register of Historic Places	A register of districts, sites, buildings, structures, and objects important in American history, architecture, archeology, and culture, maintained by the Secretary of the Interior.
Nitrous oxide	Oxides of Nitrogen (NO_x) are major contributors to smog formation. Nitric oxide (NO) is a direct product of high temperature combustion. Nitrous oxide (NO_2) is a secondary product resulting from chemical reactions on nitric oxide in the atmosphere. Nitrous oxide, much like CO, has an affinity for hemoglobin.
Non-point source	A source of pollution where there is no discrete discharge point. Typical non-point sources include the runoff from urban areas or agricultural land. Non-point source contamination or pollution cannot be traced to any single location where it occurs. Examples include runoff from lawns containing pesticides, sand and salt applied to roadways, or animal excrement. The opposite of a non-point source is a point source, such as a pipe the discharges into a river.
Oligochaete	A group of segmented worms, i.e. earthworms.
On-site disposal systems	Commonly know as "septic systems," include any type of system where domestic sewage is disposed of on-site. This is typically allowed only where public sewers do not exist. On-site disposal systems in Massachusetts fall under the regulations know as Title V.
Outwash	Pertaining to soil of glacial the and/or riverine source, as in the outwash of sediment particles.

Overdredge	To intentionally dredge deeper than the depth necessary for the principle purpose such as flood control or navigation.
Particulates	Small airborne particles of carbon products, metallic salts, ash, and dust.
POTW	Publicly Owned Treatment Works. Typically refers to a municipal wastewater treatment plant.
Polychlorinated biphenyls	A class of organic compounds formed by chlorination of the biphenol molecule. Compounds are typically found in oils used in old electric transformers.
Peak hour traffic	The number of vehicles utilizing a road during the hour of its maximum use, typically the morning rush hour.
Perched	The term is generally used in regard to groundwater resources which, due to local geology, are elevated and confined above the regional groundwater levels.
pH	A measure of the acidity or alkalinity of a material, liquid or solid. pH is represented on a logarithmic scale ranging from 0 to 14 with 7 representing neutral and acidity increasing with decreasing value.
Phosphorus	One of the primary nutrients for plant and algae growth.
Photochemical oxidants	A class of air pollutants that encompasses a complex of reaction products of nitrogen oxides and hydrocarbons. The reaction processes by which they are generated are not understood, but are affected by light, temperature, and concentrations of nitrogen oxides and hydrocarbons. Photochemical oxidants are a major contributor to smog.
Resource Conservation Recovery Act	A federal law that defines a hazardous waste and its management.
Receiving waters	Rivers, lakes, oceans, or other water bodies that receive treated or untreated waste waters.
Recharge	The replenishment of water to the ground to supplement water resources for later release either through groundwater flows or wells.
Riffle	A sloping and rocky stream bottom.

Riverfront Area	A resource area that is protected under the Massachusetts Wetlands Protection Act. The Riverfront Area is located between the river's mean annual high water line and runs parallel with the river. The distance from the mean annual high water may vary between municipalities. For Boston, it is 25 feet and in Brookline, it is 100 feet. A more detailed explanation is found in 310 CMR 10.58(2).
Runoff	The water that flows from the surface of the land in surface streams. The portion of rainfall, melted snow, or irrigation water that flows across ground surface and eventually is returned to streams. Runoff can pick up pollutants from the air or the land and carry them to the receiving waters.
Suspended solids	Materials, such as particles of silt, clay, finely divided inorganic or organic matter, and micro-organisms, which are light enough to be carried in the water column by turbulent currents or by colloidal suspension (water particles in air or fog is a colloidal suspension).
Sulfur dioxide	oxides of sulfur are a product of fossil fuel combustion primarily from stationary sources. Sulfur dioxide is a nonflammable, non-explosive, colorless gas. As an air contaminant, it is not of primary concern in transportation air quality studies. Federal standards limit the average hourly concentration of sulfur dioxide to 0.03 parts per million.
Stratigraphy	The layering of sedimentary deposits.
Surficial	Of or pertaining to the upper most layer of soil or sediment.
Swale	A shallow depression in the ground surface where runoff water tends to flow.
Tailwater	
TCLP	Toxicity Characteristic Leaching Procedure, a method of measuring the mobility of organic and inorganic compounds that leach out of soil causing contamination of groundwater. If a compound exceeds this test limit it is likely to leach out of the soil and therefore has to be disposed in a hazardous waste landfill.

Trimorphic	Exhibits three features on the body that are distinct from others of its species. The three-spined stickleback is trimorphic.
Tubificid	A group of macroinvertebrate fly larvae that are predominantly pollution tolerant to facultative.
Turbidity	Caused by the presence in water of suspended matter, such as clay, silt, micro-organisms, and finely divided organic or inorganic matter, which causes light to be scattered or absorbed, giving the water sample a cloudy or murky aspect.
Vegetative types	Plant communities characterized by certain species and levels of moisture.
Viewshed	The area that is observed from where one is standing.
Watershed	The region drained by or contributing water to a stream, lake, or other body of water.
Water table	The upper limit of the level of groundwater; the top of the water in most wells.
Wetland	Legal definition varies from state to state. Generally, land covered by water from time to time, characterized by certain soils and plant communities.
Winkler	The basic EPA-approved method of determining dissolved oxygen in water.
Umhos/cm	Micro mhos per centimeter, units for measuring conductivity. The inverse of resistivity.
Volatile Organic Compounds	A group of organic compounds that tend to evaporate or volatilize. Compounds have a boiling point at a temperature of 200 degrees Celsius. Gasoline is composed of volatile organic compounds.
Volatilization	A process where a compound evaporates at normal ambient temperatures.
Volatile Petroleum Hydrocarbons	Massachusetts DEP method to measure contamination due to volatile organic compounds.

Weir	Structure like a dam across a water course where water flows over the top of the structure.

List of Abbreviations

ADT	Average daily traffic.
BMP	Best Management Practices
BVW	Bordering Vegetated Wetlands
BOD	Biological Oxygen Demand
BPRD	Boston Parks and Recreation Department
BWSC	Boston Water and Sewer Commission
CFR	Code of Federal Regulations
cfs	Cubic feet per second
CMR	Code of Massachusetts Regulations
COD	Chemical Oxygen Demand
cy	Cubic Yards
dBA	Decibels
DEIR	Draft Environmental Impact Report
DO	Dissolved oxygen
EA	Environmental Assessment
EA/EIR	Environmental Assessment/Environmental Impact Report
EIR	Environmental Impact Report
ENF	Environmental Notification Form
EO	Executive Order
EOEA	Executive Office of Environmental Affairs
EOTC	Executive Office of Transportation and Construction
EPA	Environmental Protection Agency
EPH	Extractable petroleum hydrocarbons
FEIR	Final Environmental Impact Report

FEMA	Federal Emergency Management Agency
fps	Feet per second
ft^2	Square feet
IEM	Independent Environmental Monitor
lf	Linear feet
LL	Local Landmark (various local ordinances). Includes properties of local, state and/or national significance designated by local governments.
LHD	Local historic District (M.G.L., Ch. 40C and special legislative acts). Includes properties of local, state and/or national significance designated by local governments. Designation date and number of properties reflect the last amendment made to the district, and do not always represent the initial date of establishment of original property count.
LOS	Level of service, for traffic.
luw	Land under water
MA DEP	MA Department of Environmental Protection
MA/HL ss.27)	Massachusetts Archaeological/Historic Landmarks (M.G.L., Ch. 9
MAL	Massachusetts Archaeological Landmark
MHL	Massachusetts Historic Landmark. Includes sites (MAL) and structures (MHL) of state significance designated by the Massachusetts Historical Landmarks which are recorded with the property's deed.
MA WPA	Massachusetts Wetlands Protection Act
MEPA	Massachusetts Environmental Policy Act
MG	Million Gallons
mgd	Million gallons per day
MGL	Massachusetts General Laws
MHC	Massachusetts Historical Commission

MOA	Memorandum of Agreement
MOU	Memorandum of Understanding
MSL	Mean sea level (elevation above)
MWRA	Massachusetts Water Resources Authority
NEPA	National Environmental Policy Act of 1969
NHESP	MA Natural Heritage and Endangered Species Program
NHL	National Historic Landmark (36 CFR 65). Includes properties of outstanding national significance designated directly by the Department of the Interior
NPC	Notice of Project Change under the MA Environmental Policy Act
NPDES	National Pollutant Discharge Elimination System
NR	National Register of Historic Places (36 CFR 60). Includes properties of local state, or national significance designated by the Department of the Interior through the State Historic Preservation Officer. Codes that indicate national Register designations include:
NRDIS	National Register District
NRIND	National Register Individual property
NRMRA	National Register Multiple Resource Area. Refers to a community-wide or area-wide designation that includes nomination of both individual and district properties. If a property has been designated as part of a Multiple Resource Area, "NRMRA" will be listed directly below the NRDIS or NRIND designation.
NRTRA	National Register Thematic Resource Area. Consists of properties related by theme; these resources mar be located over a much wider geographical area than those of an NRMRA.
NRMPS	National Register of Multiple Property Submission. If a property or district has been designated as part of a multiple property submission, "NRMPS" will be listed, with a date, directly below the NRIND or NRDIS designation for that property. It may be possible that the listing dates for the NRMPS and the NRIND/NRDIS may differ; if so, the

	official date for inclusion of the property or district in the State Register is the one noted for the individually listed property or district.
NRDOE	Determination of Eligibility (36 CFR 63). Includes properties of local, State, or national significance determined eligible for listing in the National Register of Historic Places by the Secretary of the Interior during the course of a federal undertaking. Determination of Eligibility may also occur if a property owner objects to listing, or if a majority of property owners in a district object to listing.
PAH	Polynuclear aromatic hydrocarbons
PCBs	Polychlorinated biphenyls
peds.	Pedestrians
POTW	Publicly Owned Treatment Works
PR	Preservation Restriction (M.G.L., Ch. 184, ss. 31-33). Includes properties of local, state and/or national significance; restrictions run with the deed in perpetuity or for a specific number of years. If there is an expiration date, it will be indicated below the PR date. Restrictions are held by any governmental body or charitable corporation.
RCRA	Resource Conservation and Recovery Act
RHD	Regional Historic District (special legislative acts). Includes properties of local, state and/or national significance designated by special act of the legislature. At this time, the only designated regional historic district is Old King's Highway Historic District, Barnstable County, Cape Cod (M.G.L., Ch. 470 of the Acts of 1973).
sf	Square feet
SOI	Secretary of the Interior Standards for the Treatment of Historic Properties with Guidelines for the Treatment of Cultural Landscape
SWPPP	Storm Water Pollution Prevention Plan
TSS	Total suspended solids
USC	United States Code
USGS	U.S. Geological Survey
VOC	Volatile organic compounds
vpd	Vehicles per day

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